Notes of

Lectures

upon

Chemistry

By

William Cullen M: D:

taken by

Benjamin Rush

Mr. Rouelle of Paris defines Chemi:
stry.

" La Chymie est un Art physique qui
" par le moyen de certaines Operations et
" de certains Instruments, nous enseigne
" a seperer les Corps plusieurs Substances
" qui entrent dans leur Composition; et a
" les recombiner de nouveau entr'elles
" ou avec d'autres pour reproduire les
" premier Corps ou pour en former de
" nouveau. L'utilité des Arts, & les besoins
" de la vie sont le but qu'elle se propose.

Chemistry instead of being y^e^ most ancient, is really y^e^ most modern of all Sciences. even to this day w^ch^ most of People the Idea of Chemistry is limited, imperfect and inaccurate. they do not agree concerning y^e^ nature of the Art: therefore since our notions of Chemistry are not y^e^ most common, we think it necessary to begin by giving the Ideas w^ch^ Chemists themselves have had of this Profession.

Towards y^e^ End of y^e^ 16^th^ Century, soon after Paracelsus, Lemnertus gives

2.

The following Definition of it in his
" Disputatio de Consensu & Dissensu
inter Galenicos et Chymicos " It is (says
he) the art of resolving minerals for y^e
purpose of Pharmacy & Alchemy. This
notion of Chemistry is so visibly imper-
fect that we shall not insist upon y^e
Faults of it, but proceed to Bequinus
who says " it is y^e art of resolving and
compounding minerals for y^e purposes
of Pharmacy & Alchemy " — he inspires
you a little upon his Predecessor by
adding y^e word compounding, but y^e
Insufficiency of this Opinion is so
apparent y^t we shall pass on to

Rombergs who says ye Chemistry is ye
Art of resolving and compounding Mi-
nerals by means of Fire. this is an
Improv: upon ye two former, but he
has put a heavy clog upon it when he
says "by means of Fire" ——

Macquairs Definition abounds w:
Terms as difficult to be understood as ye
word Chemistry itself. in short all who
have attempted to define Chemistry have
erred by considering it as an Art, and not
as a Science.

Dr Shaw has endeavoured to give us
a full Definition when he says "Philoso-
phical Chemistry is ye Art of dividing

all Bodies within Our power by all y^e^ Instruments within our power, but from these words it is impossible to determine what is a Chemical Operation. for instance y^e^ Method of making Shot by dividing y^e^ Lead after Fusion into small parts is really a Chemical Operation — When Sugar is reduced to powder in a Mortar it is also divided into smaller parts, yet it would be as absurd to call y^e^ a Chemical Operation as y^e^ shaving a Beard, or chipping a Block.

The great Boerhaave attempted a Definition of Chemistry, but in Reality he says little to y^e^ purpose. from his Failure in y^e^ Attempt we may con-

-clude

that y^e^ Task is extremely difficult.

To give them a more aurate and simple Idea of Chemistry, we must look upon it in a different Light from that in which it has been hitherto examined, by considering it as a Branch of Natural Philosophy. Nat. Philosophy is its Genus, but what is its Species? Boerhaave in his Methodo Studii Medici, says that Science which explains y^e^ particular Nature of Bodies, and Whereon y^e^ Formation of those Bodies depends is a Branch of Nat. Philosophy, & is called Chemistry. — This is partly y^e^ Definition we are inclined to adopt. viz: Chemistry is y^e^ part of Natural Philosophy which treats

of the particular properties of Bodies.

— To understand w.t is meant by general and particular properties of Bodies I shall illustrate it by a few Ex= =amples. it must be Observed that as y.e Doctrine of particular properties of Bodies belongs to Chemical, so the Doctrine of general properties of Bodies belongs to mechanical Philosophy. For Example, Gravity is a general Property of all matter, and therefore comes under y.e Consideration of Mech.l Philosophy. but y.e Ductilety of Gold & y.e Hardness of the Diamond are particular properties of particular Bodies & therefore all under=

y^e Class of Chemical Philosophy. to illus-
trate y^e Above Definition further, let us
consider a Knife. the Cutting of it depends
upon its Drawing which is a wedge. this Form may
be given to any other Body. it is therefore
a general property, and to be considered as
belonging to Mechanical Philosophy. for
Gold wrought into y^e same Form would
cut equally as well, if y^e hand with which
was to press always in y^e same plain with
its Edge. but seeing that is a moral Im-
possibility, we must make Choice of a
Substance y^t will bear to be turned a little
from its perpendicular height or position
& will return again to y^e same. this pro-
perty is called Elasticity. it is found very

greatly in Iron. the Chrichton of Iron for
a Knife as possessing a particular propert
=ty is an Object of philosophical Chemistry

No other Definition y^{t} I know of except
this w^{ch} we have adopted can give y^{e} young
Student an Idea or fixt Rule by which
to distinguish what properly belongs to
Chemistry. Dalton flatters myself y^{t} my
Definition may be applied both in Phy
and other Arts. But y^{t} you may more
fully comprehend my meaning, & be
able to distinguish better y^{e} genral fro
y^{e} particular properties of Bodies. I sha
delay you wth a few more Examples.
In Physic y^{e} Doctrine of Stimuli is ex
tensive. The Idea is taken from a Spe

In considering y^e^ Animal Oeconomy we
see a great variety of Stimuli, ie Bodies w^ch^
act upon it by Irritation & Spurning. y^e^
most evident kind of Stimuli are those w^ch^
are sharp-pointed. but there are others
whose particles we cannot examine, &
are therefore ignorant how they act as Sti-
-mulants. of late there we have divided
Stimuli into Mechanical & Chemical.
-The first are those which act like them
by y^e^ w^ch^ their sharp-points - the second are only
known by y^e^ properties of y^e^ Bodies in
which they are found. all y^e^ we know of
them is, that they are certain sharp irrita-
-ting Qualities inherent in certain Substan-
-ces. - all y^e^ Difficulty then remaining is

to distinguish wch are general & wch are
particular properties. for ye better under-
=standing of this take an Example.
Here is a Miniature of Chalk and Sand
put into a Vessel. it is required to seperate
the Miniature. Spour water for this pur-
=pose upon ye Miniature, & stir it briskly.
When I cease from stirring ye large par-
=ticles of Sand quickly subside, & ye Chalk
remains suspended in ye water. if the
water is then decanted it carries of the
greatest part of ye Chalk leaving the
Sand at ye Bottom of ye Vessel. ye Pour
being repeated as often as is necessary
leaves ye Sand perfectly seperated from

Chalk. if instead of water I add vinegar or any other acid, y^e Chalk effervesces w^th the Acid, and forms a uniform Body, nor will y^e Chalk be separated from y^e Acid by any length of time, y^e Sand at y^e same time remaining unchanged. now let us enquire into y^e Rationale of these different Methods of performing y^e Operation, & endeavour by y^e Assistance of y^e Theory we have adopted which of these Operations can properly be called Chemical. y^e Success of y^e first Method depends upon Fluidity a Property not only of water, but of Wine - Rum - Brandy &c &c any of w^ch w^e have performed y^e process equally as

well as water. it depends likewise upon
y: respective Size and weight of y: Sand
& Chalk. This Operation is then entirely
Mechanical. in y: second Operation Acid
= dity was y: Instrument. Acidity is a
particular property, therefore y: Operation
is Chemical.

Some argue ag:st our pretending to
establish general and particular properties
from our not being sufficiently acquain
= ted w:th Nature to know how far partic
= ular properties extend: & some late
Discoveries which prove y: Quicksilver
may be rendered solid, & y: hardest Diamond
liquefied seem to strengthen this Opinion
but as long as certain properties appear

in certain Bodies very constantly, such may be reckoned proper Objects of Chemistry.

From these Examples we may venture to conclude that Chemistry is that part of Natural Philosophy wch treats of ye particular properties of Bodies, and teaches us by various means to induce them when they are not, and destroy them where they are. —

Having now distinguished what does, and what does not belong to Chemistry, we shall next proceed to ye Doctrine of this Science; but previous to this it may be necessary to say something of the Method of conducting ye Study of Chemistry wch

the Addition at ye: same time of a few
Cautions that may warn ye Tyro ag:
ye: innumerable Errors yt occur in Che-
-mical Writers. —

Dr. Shaw excited ye: Study of Chemistry
more perhaps than any other man
whatsoever. but such projects as we find
in Shaw Becher &c are carefully
to be avoided; for you will find many Defects
in Science & many Difficulties in practice
of which Theory is not aware.

Chemistry exercises ye Memory more
than ye Judgement. Our Business
be therefore to relieve this Faculty, & must
done by means of Order. For this purpose

I shall give you y^e^ general plan w^ch^ I intend to pursue; from w^ch^ you will gain three two advantages 1^st^ you will be directed by it to particular parts & 2^nd^ you will be enabled to keep in view y^e^ connection of the whole. ——

The ultimate End of Chemistry is to learn y^e^ Causes of particular properties of Bodies, & y^e^ only means of arriving at that End is by Induction.

Every Science may be reduced to two Head. History & Philosophy. under y^e^ historical part I shall deliver first an History of y^e^ Objects of Chemistry. Secondly a general Acc^t^ of the Operations & Instruments

of Chemistry, thirdly, the Chemical History
& y: Knowledge of those Facts which must
lead us to & y: Knowledge of Causes, or
the philosophical part of Science. Facts
must be collected under & y: Titles of & y: parti
-cular Bodies to which they belong; & the
means pointed out by which their particu
-lar properties are discovered. together with
& y: manner in w: they are induced or destroy
This part of the Study is extremely useful
independant of & y: Causes of Qualities. I
no Person will doubt & y: Utility of knowing
that Antimony has an Emetic Quality
& y: means whereby this Quality may b
encreased or diminished, yet we do not k

the Causes of y^e^ Quality. Again it is ex=
=tremely useful to know y^t^ Aquafortis
dissolves Silver, but that it has no Action
upon Gold, yet we do not know why it dis=
=solves the One and has no Effect upon the
Other. —

In delivering the Chemical History
of Bodies, you will frequently be refer=
=red to y^e^ Relation of Bodies to each Other
& to the Means by which this is discovered.
I might illustrate this by an Example
but as I shall be obliged to employ Terms
w^ch^ I have not yet explained, it will be
better understood hereafter.

You might here naturally enquire

w:^{ch} Books are to be read? - I am sorry
to say y:^{t} upon y:^{e} Subject of Chemical
History, no Books are written w:^{ch} I can
recommend to You, because they are
incorrect deficient & without Order. Nei-
=ther is there any Book yet published in wh-
y^{e} Language, or general matter of Chemist-
is preserved accurately. Even in Macquer's
-mistry, a Book w:^{ch} I would most safely r-
-commend to your Perusal I shall mu-
Oftener have Occasion to refer you to th-
Errors than to the Excellencies of y:^{e} Auth-
- its chief Use is to show y:^{e} common Meth-
of conducting Chemical Processes.
The first part of our Plan wil-

contain two principal parts. 1.st an
Explanation of y.e Language of Chemistry
2.nd an Acc.t of the Objects of Chemistry.
This part you must consider not only
as applicable to Chemistry, but likewise
as a Compendium of Natural History.

The Second part of our plan will also
contain two principal Heads
1.st the Rules of practise
2.nd An Introduction to y.e Theory of Che=
=mistry. — The Order of the

Third part requires a particular
Explanation. I shall therefore defer
speaking of it at present. —

We shall endeavour in explaining the
Terms of Chemistry to assign proper & distinct

Ideas thereto. a needfull Lesson this! which
cannot be learned from any Glossary or
Dictionary. if upon any occasion one
single Term occurs w:h does not give you a
clear Idea, rest not. 'till by considering
your Notes - reflecting on w:h you hear,
enquiring among your fellow Students you
become perfectly acquainted w:h its meaning.

It will be probably expected y:d I should
deliver Something concerning y:e Doctrine of
Qualities: But I must own myself Unpar-
tial in this affair. Besides in y:e present
State of Chemical Knowledge it will be
impossible to render it compleat. I resolve
however in this Course to give y:e History of
y:e chief Articles of Qualities viz Fire

which will be found to have some Connection & to throw some Light upon y^e^ Other. You must in this, as well as in Other Subjects indulge me in giving much Theory. For tho' no Body would recommend a Wantonness of Theory less than myself, yet I must be Advocate for its Utility under proper Restrictions. it is a most powerful Means of exciting us to Experiments & consequently y^e^ Knowledge of Facts. Nothing will more enable us to detect Fallacy & Sophism than a Discussion of Theoretical Opinions.

I shall proceed to give you some Advice w^h^ Regard to your Conduct in Theoretical Inquiries; for I shall not only endeavour to make you acquainted w^h^ Chymistry as

applicable to y^e^ purpose of y^e^ Physician,
but of the Philosopher also. we shall find
likewise that y^t^ y^e^ Knowledge of Facts
& Practice will be considerably enlarg
by y^e^ means employed for Theoretical
-quiries. But to enable You to follo
me, & to make any Advances your
-selves in Chemical ~~Knowledge~~ Philo
-sphy much preparatory Knowledge
necessary.

Logic is a very necessary part of
introductory Learning. By Logic
many y^e^ Analysis of y^e^ humane
such as may be found in M^r^ Locke
excellent Treatise upon y^e^ humane
Understanding. This is not only

necessary in Chemistry, but also in every other Science where there is Danger of Error. — I cannot but lament y^e^ y^e^ Students of Medicine in this University are not obliged to go thro certain preparatory Branches of Learning: for many of the Gentlemen who come here are so ignorant in this Respect, that it is impossible for them to make any tollerable progress in Medicine. in recommending y^e^ Study of Logic, if we could venture we would recommend it in a particular Form, I mean y^e^ Study of Scepticism. not an Obstinate Disbelief of every thing. and every Fact, but y^e^ kind of Scepticism

Which y^e Poet calls

" The slow consenting Academic Doubt "

The most common Error in our Reasonings proceeds from our assuming false premises — Here in Natural Philosophy and particularly in Chemistry but be Obtained by Induction. Since we have no Books on this Subject which I can recommend to You I shall endeavour to lay down some Rules for assisting You in y^e Collection of Facts. I shall divide these Rules into two Heads

1: On the Choice of Facts.

2^dly Mechanical Rules concerning y^e Manner of disposing them. —

We must collect Facts by putting them

in writing, not only from our own
Experience but from Books. all Facts
which we find in Books y^e^ do not deserve
a second Reading must be transcribed
into our own Tables. but Thus y^e^ greatest
Caution is necessary to collect none but
true Facts, for many writings especially
of the Alchemists contain nothing but
y^e^ most palpable Falsehoods. Thus Fallacies
are considerably owing to y^e^ difficulty of
making nice Experiments, & of applying
our Senses to y^e^ Examination. Thus y^e^ Darque
of making Other (w^ch^ has y^e^ Object of y^e^
Chemists Attention ever since y^e^ Year 1732)
has never been obviated 'till within these

two Years. Again D^r Cullen not long
-since ago settled y^e Heat of y^e human
Body at 82° of Farenh^t Thermom^r: but
it has since been raised to 98° or 100°.

Besides Authors are liable to relate false
Facts thro' mistake. Thus for Example M^r
Geoffroy has told us y^t Vol: Alkali has
a stronger Attraction to Acids than Ab-
-sorbent Earths, Whereas y^e contrary is
now found out to be true. You must
be especially upon your Guard against
such Facts as are deduced from Theory: for
when Macquer says y^t Salt is a Composition
of Earth and Water, he does not assert it from
his own Experience, but from his Theoretic

Opinion. he again affirms upon the same Authority that Metals &c: are formed of a vitrifiable Earth & Phlogiston. Which from Experiment you will find to be false.

The concurrent Testimonies of a great Numbers of Authors must surely have considerable weight, but even here we are liable to Deception, since Facts have been received as Truths from a Series of Authors implicitly, many of which when put to the Test of Experiment have been found to be false.

Microscopical Observations are always to be in some Degree distrusted. For instance Leuwenhoecks Discoveries concerning the

Globules of Blood have long been received as Truths, but Mr. Senac says they are lenticular & D. Haller that they are Spherical.

All Facts which are said to be universal are likewise to be disputed. General principles are certainly very necessary, but at the same time very difficult to be established & always to be received with Diffidence. The Effervescent Mixtures have all been supposed to produce Heat, but we know now that some of them produce Cold.

We are very liable to Mistakes in assigning Causes for Phaenomena on a Supposition that certain Circumstances always produce certain Effects. Dr. Priestley having shewn a great Degree of Heat was long pronounced to be deleterious to Animal

even after it was reduced to its ordinary Temperature, but this is a mistake, for Air passing thro a Tube that is red hot is not rendered unfit for Respiration, tho it becomes highly deleterious after passing thro burning Bodies.

Authors are sometimes mistaken in assigning the cause for an Effect which several conspired to produce. Thus it has been asserted by Dr Irwing of water was only owing to Cold, but Water in its fluid state contains a great Quantity of Air. & it must be in a great measure deprived of this Air before Freezing can take place.

We find considerable Inconveniences also from not knowing the particular Circumstances

of Facts, which the Author frequently neglects to mention. For Example we are told that Brass is formed of a Mixture of Zinc & Copper, yet they do not say whether any Effervescence succeeds the Mixture. Whether Heat or Cold is produced — Whether there is any Separation of parts — Whether the Specific Gravity is lessened, or encreased — Whether there is any Alteration in the Appearance of their Texture — & lastly whether any Change takes place in the Ductibility of either. From these Examples we may conclude that there is hardly any one Fact sufficiently pursued for the purposes of Philosophy or Arts. ——

Of the Objects of Chemistry

All y^e^ particular Bodies w^ch^ w: are the Objects of Chemistry may be referred to One of these ~~five~~ Forms. Viz:

1: Saline.
2^dly^ Inflamable
3^dly^ Metallic
4^thly^ Earthy
5^thly^ Watery
6^thly^ Aerial. except perhaps certain Animal and Vegitable Substances w^ch^ w: as they cannot w: propriety be reckoned among any of these may constitute a
7^thly^ Form.

I shall explain by a ~~Diffs~~ Definition of each wherein consists y^e^ Differences of

the six Forms. but you must not expe
my Definitions to be entirely perfect
since I shall only endeavour to give you
such general Ideas of their names as
save our present purpose, & enable
you hereafter to enter upon an Exa
-mination of the Chemical Bodies.

I shall now proceed in y^e Order of Natu
-ralists, distinguishing Bodies into Gen
& Species.

Saline Bodies

These are sapid & miscible w^th water. soa
likewise y^e next Class of Bodies. we must
therefore have Recourse to a 3^rd distinc
Character & that a negative one. Def:
n Saline Bodies are therefore sapid. miscib

the w: water and not inflamable.

Inflamable Bodies

The Definition of these is perhaps more perfect, since the Explanation of the Term inflamable is a Definition of the Clasp. Def: — a Body is Inflamable if, when applied to burning Fuel, it also begins (& tho withdrawn from y^e Contact) continues to burn w: an Obvious Consumption of the whole, or part of its Substance receiving on its Surface a luminous Vapour called Flame. The Only Exception I know to this Definition is Charcoal, w: tho properly belonging to y^e Clasp of Inflamables does not produce

any Flame.

Metallic Substances

Def: " These are shining Opake insipid Bodies, - not soluble in water - not inflammable - but when exposed to certain degrees of Heat are fusible, & recover after cooling their Original Texture "

Earthy Bodies

Def: " These are dry insipid - insoluble in water - not inflamable or fusable in the Fire " — no pure Earth is fusable except by Addition of foreign matter. Chemists however have divided them into fusable & not fusable. That you may not then be embarassed with these Terms, I shall

add " if friable they do not convert into y^e same form as before but are converted more or less into Glass.

Watery Bodies

Def: " Water is an insipid, pellucid Body which in y^e Ordinary Temperature of y^e Air is fluid, but when exposed to 32° of Farenheits Thermometer becomes solid & friable, or if exposed to 212° of Heat in the same Thermom^r is dissipated in Vapour.

Aerial Bodies

Def: " Air is a thin elastic Fluid. both w^ch properties of Elasticity & Fluidity it preserves independant of all Temperatures. "

We shall now proceed to explain the

Division of y^e several Forms beginning
the Saline. I have employed y^e word
Form, because y^e various Bodies
mentioned are not permanent, but
change their particular Qualities
uniting w^th other Substances or by some
other means.

Saline Bodies are either simple
or Compound. The Simple Bodies are
such as preserve a uniform Appearance
of Texture in y^e most minute parts which
we can examin. The term Simple is
also applied to y^e principal Ingredients
of a Compound, altho' some of these
Ingredients may perhaps be resolved

into Others w^ch compose them. Those Bodies are called Compound w^ch are formed of Parts possessing different properties.

The Simple Salts are either Acid or Alkali.

Acids have a peculiar Taste called sour, changing Syrup of Violets or other blue Vegitable Juices into a red Colour.

Alkalies are a Solid, soluble in water, effervescing when combined w^th Acids & changing the blue Colour of Vegitables into a green.

Acids are the Vitriolic, Nitrous, Muriatic & Vegitable so called from y^e Substances which usually afford them. There may be other Species of Acid, but those mentioned are most generally known.

Alkalies are of two kinds Fixed viz

fixt, and volatile. the former have very
little Odour, & will sustain a considerable
Degree of Heat without Dissipation. the
latter emit a very pungent Odour, and
readily exhale in a very gentle Heat.

Neutral Salts are formed by a mixt
of Acid and Alkali in a certain propor
& have been called two Salies Salsi as com
=pound of two Salts. the Term neutral
applied because they possess y Propert
of neither Ingredient before mixture b
an a tertium quid. thus nitre or
is a neutral Salt compos'd of Nitro
Acid, and fixt Alkali does not effect
the ℔ w. y: same Acid, nor change y Lymus
Violet red or green.

The Vitriol is an Example

a Metallic, and Alum of an Earthy Salt. – Macquer very improperly calls Alum a Neutral Salt, because it is not composed of an Alkali, nor are y^e^ properties of its Acid changed. for Alum applied to y^e^ Syrup of Violets changes its Colour to a red.

Inflamable Bodies. of these there are not so many Species as we might at first sight suppose. their Inflamability generally depending upon some particular Ingredient. Thus if we extract y^e^ Oil from wood – the Sulphur of Pitcoal, or the Alkohol of wine, the Residuum of these several Bodies will become incapable of Inflamation, & perhaps to these three Forms of Oil, Sulphur & ardent Spirit we

may, almost without Exception refer
Inflamability of all Bodies. Those
Forms are again supposed to depend
upon One simple Phlogiston to which
y: Inflammability of all Bodies w
-ever ~~may~~ are chiefly to be attributed.

Oils

This is properly of a fluid Form, except
when it is coagulated or entangled b
y Interporion of some other Body. I shall
therefore define it to be an inflamable
not miscible with water.

Sulphur is a dry solid
inflamable Body not soluble in water.

Ardent Spirit is an in
-able Fluid readily miscible w. water.

Oils are of three kinds viz: Animal, Vegitable, and fossil.

The Animal & Vegitable are subdivided into expressed, Essential & Empyreumatic. The Term expressed is by no means proper or universal. for many of y^e Oils called Expressed Essential may likewise be obtained by Expression. we shall therefore define y^e Expressed Oils to be insipid, inodorous, and not soluble in Ardent Spirit. to these belong Fats, Gums & wax.

Essential Oils have an acrid Taste- are soluble in Spirit of Wine, and retain more or less of the Taste and Odour of the Subject from which they are extracted. Essential Oils are very generally tho' not

altogether peculiar to y^e^ Vegitable King-
-dom, for y^e^ Animal Substances Castor
& Musk are of this sort. to these Oils
may be referred Balsams & Resins. they
do not differ but in consistence; for the
Balsams become indurated by exposure
to y^e^ Sun or Air they are called Resins. the
Term Essential does not exclude all the
Expressed Oils, for the Expressed Oil of
Mace (so called from y^e^ Method by which
it is obtained) retains y^e^ Taste and Odour
of the Subject from which it is extracted,
is therefore with y^e^ strictest propriety an
Essential Oil.

Empyreumatic Oils are acrid & pungent
in a great degree. they do not retain the

Taste nor Odour of y^e^ Subject from which they are Obtained, but acquire a peculiar burnt Smell called Empyreuma, & hence their Name. to this Head belongs Tar.

Fossil Bils of this there is but One Species called by y^e^ Naturalists Naptha which is very clear and volatile. when it is become less pure it is called Petroleum. when thick like a Balsam it is called Pisselæon or Barbadoes Tar. when hard of the Consistence of Resin it is called Asphaltum or Bitumen Judaicum. this Bil may be distinguished from y^e^ Vegetable by its Taste and Odour, & from y^e^ Essential & Empireumatic by y^e^ peculiarity of its Taste and Odour which can only be learned by

Experience, we may therefore define it
to be an Oil of a peculiar Taste & Odour
not readily soluble in Ardent Spirits.

There are various Fossil Inflammable
which have been called Bitumens, but
& Term Bituminous cannot be prop
applied to any Bodies, except those w.
owe their Inflammability to Fossil Oil.
to the Head of Oils belongs Æther which
is an Oily Fluid extremely inflammable
volatile, and of a peculiar Odour & Tast
not to be mixt w.th in any other Body, an
not miscible w.th water.

Sulphur is of one kind only, called
England Brimstone, but in Latin it

distinguished by y^e^ Epithet Mineral.
to distinguish it from an inflammable
principle called by y^e^ latin & French
writers Sulphur.

Ardent Spirit. the word is frequently
applied w^th^ y^e^ utmost impropriety to the
kinds as Sp^ts^ of Nitre Vitriol &c. & even
to such of y^e^ Essential Oils as are of very
great Tenacity as Sp^t^ Terebinth &c. now to
avoid Confusion we ought to apply y^e^
Term only to such Spirit as is obtained
from vinous Substances w^ch^ in its purest
State is called by y^e^ Chemists Alkohol.

Metallic Bodies.

To the former Definition of them we may
add y^t^ they are Bodies of y^e^ greatest Spec.
fic

Gravity in Nature. They are divided into
Metals, and Semimetals.

The Metals are { Gold, Silver
Lead, Tin,
Copper, Iron
& Quick-Silver.

The two first of these are called noble or
perfect. the five last Base or imperfect
- This Distinction has arisen from y
extraordinary Resistance w: y & y former
make to y Action of Fire & Air. it has
been supposed y: Gold could bear y^d most
intense Heat without being changed
but later Experiments discover y in the
Focus of a large burning Glass Gold may
be quickly destroyed. Gold & Silver have
have both been found to withstand y^e
of a ~~large~~ Glass-House Furnace many

weeks without any sensible Change.

Dr: Boerhaave averred 2d y: if any Body could be of equal Speciſic Gravity it wd: poſſeſs all other Properties of Gold. but this is also found to be a mistake. for Platina which has none of y Properties of Gold is of equal or perhaps greater Speciſic Gravity.

I have added Lunick-silver to y 2d Metals because it is found y: under a certain Degree of Cold it becomes ductile, malleable & solid, and these properties of Ductibility & Malleability distinguish a Metal from a Semimetal.

The Semimetals are { Zinc-Antimony Bismuth-Arsenic Platina-Cobalt & nikil.

These are distinguished from y^e^ Metals by their friable Texture. but Zinc having been found to retain some Degree of Malleability has given occasion for the = Phrase to divide Metal: Sub: into Malle = able, Semimalleable & friable.

Naturalists have long been doubtful in w^h^ Class to place Arsenic. D^r^ Boerh^a^ enumerates it among y^e^ Sulphurs. but now we know y^e^ y^e^ Substances to which y^e^ name has been applied have a Metal matter for their Basis.

Metal: Sub^s^ are generally found in a State of Ore. ie blended or mixed with w^h^ other Bodies which most frequently are Sulphur, Arsenic or both. When Arsenic

united w: 2h earthy matters, ~~thus~~ as to form a heterogeneous Aggregate, such Ores are said to be inherent in matrices.

Earthy Bodies

These are divided into Absorbent - Crys-
-talline - Argillacious & Talky.

Absorbent Earths are very improperly called Alkaline, because they do not pos-
-ess any of y: Qualities of Alkalies, except that of destroying Acids. y 2d Term Calcarious is also very improperly ap-
-plied to them, because they are not all convertable into Quick Lime. these Earths are soluble in Acids.

Chrystaline Bodies are not at all acted upon by Acids. - they are friable &

of such Hardness as to strike Fire with
Steel. These are y^e^ Substances com-
-monly employed for making Glass
by means of first Alkali w^ch^ renders
them fusable. from this Circumstance
they have been improperly called Vitres-
-cent: for without y^e^ Addition of an
Alkali they are no more Vitrescent than
other Earths, and indeed all of them by
proper Addition become vitrescent.
Besides y^e^ Mountain Chrystal, which
the Earth took its name, every kind of
precious Stone, Flint or Sand belong
to this Class.
Argillacious Earths are not readily
or obviously soluble in Acids. They are

not hard enough to strike Fire w.th Steel: if
broken down & formed by water into a
Paste. they become viscid & ductile. this
Paste exposed to y.e Fire acquires very
great Hardness. these Characters are
sufficient to distinguish y.e Argilla=
=cious from y.e other Classes of Earths.
but we may also add y.t they absorb
water w.th a great Increase of Bulk.

Under the Head of Earths I comprehend
all those Substances called Stones: M.r
Reameur thinks he has found an accu=
=rate Distinction between Earths & Stones
viz: that y.e Earths swell and Absorb water:
but this a property of y.e Argillacious only.
- in my Definition of Argillacious

Earths. I have said y^t they are not di-
-viously soluble in Acids, or Au^r of Som
late Discoveries by which we are inform
that by very strong Acids under a certa
Management, they may be resolved
y^e Crystaline & Absorbent, so y^t we ar
wrong in enumerating four kinds o
simple Earths.

Talky Earths are found disposed i
thin plates or Fibres. They suffer no chan
from y^e Action of Fire or Acids, neither
they become viscid or harden when mix
into a Paste. of this Class is y^e Asbestos
is compoud of Fibres y^t by proper Ma
-nagement may be made into Cloth
or Paper. these must be freed from Filth

and Old writing by burning instead of washing. D^r Brookman a German has published a Book upon y^e Asbestos & a Copy printed on y^e Substance he presented to a German Prince.

Gypseous Bodies are not soluble in Liquids, nor yet hard ens to shike Fire w^th Steel. When mixt w^th water they do not become ductile or viscid, but acquire a stony Hardness. exposed to Fire they fall to powder w^ch has not y^e Properties of Quick-Lime. These Bodies are disposed in Lamina or Fibres, & have been placed among y^e Earths, but they are undoubtedly saline Substances commonly called Selleites w^ch are formed by a Species of Calcarious Earth & Vitri-

olic

Liquid.

Of watery Bodies

There is but one Species of water perhaps in Nature of which we have already given a general Description. we are now able to examine this perfectly free from other matters. When water is insipid & without Odour it is called Common — But when it issues from y^e Bowells of the Earth so strongly impregnated with foreign matters as to acquire a Taste & Odour w^ch are obvious to our Senses it is then called Mineral.

Naturalists have commonly confined themselves to 4 or 5 preceding Terms. The

hitherto pursued this plan, but now I shall venture to add a 6th. the Aerial.

Aerial Bodies

Air wherever it is met with in a pervate State is always Elastic. Its particles have y^e^ power of repelling each other. I think there is some Reason to suspect that Air is of two distinct Species, which I shall call Common & Mephitic. The former is indispensably necessary to y^e^ ~~Respiration~~ Life of Animals & y^e^ Support of Flame. whereas y^e^ latter is extremely deleterious to Animal life & suddenly extinguishes a Flame applied to it.

The Distinctions wch. I have made between y^e^ two Fluids Air & water are

sufficiently accurate. we may however add 4: water is very nearly incompressible and is only capable of lateral motion Gravitation to 4: Center: whereas air a very Elastic Fluid compressible in proportion to 4 Force applied, and by parts also by repelling also expan each other quo quoversum.

Now to conclude this Subject of 4 Elements of Chemistry I must observe, that 4 particular Character of Bodies which have given are not sufficiently accurate indeed can we expect Definitions to be quite perfect, since 4: Bodies to be defined are unsteady in their Qualities. thus we find 4: water may be converted

into Earth or Vapour – Air may loose its Elasticity and become fixt – that Quicksilver may be rendered solid, & Gold itself which hitherto has been looked upon as permanently fixt, dissipated in Fume by y^e^ Heat of a Burning Glass.

We shall now add some general Observations on the Objects of Chemistry. Many Philosophers have thot y^e^ Matter was divisible ad Infinitum. Others suppose that there are Limits set to y^e^ Divisibility of Matter, at least by any powers in Our System. The following Argument taken from y^e^ Appearance of Nature is not unfavourable to this Hypothesis. We observe y^e^ Animal and Vegitable Bodies continue

to perish & to be again renewed. their
Destruction as far as we can see depend
upon a Seperation of these parts. now if
ultimate particles of Bodies are liable
to Change and Division, we should can
see a proportionable Change in ye Bod
ch
w: they constitute: Whereas we find tha
Animals & Vegitables have continued fo
ye Creation perhaps to Encrease each Oth
under ye same Form & Appearance.
Isaac Newton illustrates this Opinion
any Example from ye works of Art. if
be an Arch of a given size be built
Stones properly adapted to it, it will
be difficult to destroy & again rebuil
provided ye Stones remain unchang

but if the Stones by any means become
altered either in Shape or Magnitude, it
will be impossible to produce an Arch of y^e
same Size precisely w^th y^e former out of
such Materials.

To consider therefore y^e Objects of Chemistry
more generally we must look upon them
all as Corporeal Substances w^ch possess par-
-ticular Properties. These are either Elements
or Mixts.

Elements or Atoms as they were stiled by
y^e Greek Philosophers are y^e minute par-
-ticles of Matter w^ch are no ways changeable
or divisible by any powers in Our System.
These Elementary parts of Matter are of
different Kinds and Quality; for if the sim-
-ple

Elements were all of one kind there could be no mixts in nature, but every mass of matter would be a simple aggregate. mixts therefore are formed of two or more Elements. those atoms in a seperate state are not objects of our senses — Chemists however have occasioned much confusion, by calling y^e most minute parts of matter y^t can be examined by human Art Elements, whereas mixts & perhaps y^e most simple Bodies w^ch we can possibly examin. it has therefore been thought necessary to divide Elements into

1: Physical otherwise named Atoms.

2^nd Chemical, commonly named Principles

The former of these are rather inferred than

demonstrated, & perhaps when most they
often evade our senses. we shall illustrate
this by y^e following Example. a Grain of
Musk will perfume every part of a large
Room; that is every Portion of Space in y^e
Room will be filled w^th Odoriferous partic-
-cles, and this will continue for several
Days without any sensible Diminution of
y^e Musk either in Bulk or weight. nowwe
cannot suppose y^e Those particles are phy-
-sical Elements, but rather that they are
composed of two or more of these, notwith-
-standing their Minuteness.

Dr. Athal & his Followers have conside-
-red Mists as composed of simple Elements.
Those have been called also Secondary

Principles. two of these Mixt form a Com-
-pound. two or more Compounds a de-
-compound. two or more of these form a
Superdecompound &c &c.

There is a Foundation in Nature for these
Terms, but I shall not adhere to them du-
-ring this Course, because it is extreme-
rare that we can determine by exact Degrees
of Composition which takes place in any
Body. This becomes more uncertain since
perhaps all Objects that are Obvious to Sen-
ses are Mixts or Compounds. I shall
therefore use by Term Mixt or Compound for
every Body which is divisible into parts of
dissimilar Qualities. —

all Sensible Bodies may be consider-

as Mixts, that may be resolved into con-
-stituent parts, or as Aggregates that
may be divided into integrant parts.

The Resolution of the parts of a Mixt
implies a Chemical, and 2d y. Division of the
parts of an ~~Integrant~~ Aggregate a Mecha-
-nical Operation. to illustrate our Ideas
of this Term let us take y 2d following
Example. Nitre considered as a Mixt
may be resolved chemically in to its two
constituent parts Acid and Alkali, when
no Appearance of 2d y. Neutral will be left.
Again we may consider a mass of Nitre
as compond of Particles containing such
a Proportion of Acid and Alkali, as that
each particle shall be a perfect Neutral,

such Particles are called y^e Integ: parts
i.e parts w^ch if united into a collective
would form a perfect Nitre. if that fou
Portion of Nitre be reduced by mecha
=nical means to parts of such minuteness
as y^t any further Division would cause
Separation of its constituent parts Aci
Alkali, the Nitre may be then said to be
divided into its integrant parts. anly
=gregate may be looked upon as an Unit
to any number of Individuals or Integ
Parts.

To distinguish an Aggregate from a
Mixt. it is enough to know y^e Number of
parts of their Connection. we must al
y^e 4 parts of y^e former are all perfectly sim
=la

While those of the latter are dissimilar;
- yet even this is not Absolute, for when Gold
is intimately dispersed thro' a stone the
mass must be considered as an Aggre-
:gate, tho' it contains various parts.
we may likewise say y: in Order to
form a Mixt, the constituent parts
should be perfectly blended w: each
other / as we say / per minima.

This much has been said to enable
the young Student fully to comprehend
y: meaning of the Terms, & to establish
distinguishing Characters, whereby we
might know w: are and w: are not Chy:
:mical

Operations. the Division of y^e^ parts of Aggregates is Only reckoned Chemical when particular Methods are employed.

Mr. Venelle confines y^e^ Operations of Chemistry to y^e^ Resolution & Composition of Bodies, but this is not sufficiently extensive. in y^e^ Sublimation of Sulphur for Example no Resolution or Composition takes place, & yet no Body will deny that this is a Chemical Operation.

Dr. Athal & those of his School have considered Bodies as Mixts or Texts. Mixts he considers as above describ

but he does not call Bodies Texts Un-
-less they have peculiar Properties
arising from their Texture & y^e Arrange-
-ment of their Parts. include Antimony
the Parts are disposed in Lines resembling
Needles: hence we see a peculiar Pro-
-perty arising from a certain Arrang^t
-ment of parts. a Tube of Lead from
y^e Arrangement of its parts is whatwe
call a Text, or as Others have termed
it an Organic Body: but Glass wood
or any other Metal &c would be capable
of receiving y^e Form of a Tube as well

as Lead; Thus y^e properties of Fest depend upon y^e general Properties of Bodies. and consequently are not y^e Objects of the Chemical but of the Mechanical Philosophy.

Of the Operations of Chemistry

We now proceed to a general view of the Operations of Chemistry. in y^e prosecution of this Subject I shall endeavour to make you acquainted w^th y^e Terms relating to y^e Operations, and general Rules for y^e practise of Chemistry: together w^th an Introduction to y^e Theory of Chemistry - of Chemical Operations and y^e Chemical properties of Bodies. I shall begin by laying down y^e following fundamental Principle

to wit: perhaps there are very few Ex-
-ceptions in Nature Viz: — That
all y^e Changes of y^e Qualities of
Bodies produced by Chemistry are
all produced by Combination and
Seperation. under which Terms I
comprehend Reaction & Condens-
-ation. This is proved by Induction. &
may be rendered very probable a priori
To illustrate this Proposition I shall
mention y^e process for decomposing and
again combining y^e constituent
parts of Nitre, and to this Instance
I shall occasionally refer during the

part of y^e^ Course. Nitre applied to burning Fuel is decomposed. i.e. its Acid flies off by y^e^ Deflagration. & y^e^ Alkali remains alone. if to this Alkali a portion of Nitrous Acid is added an Effervescence will take place, and if y^e^ Acid be exactly saturated w^th^ y^e^ Alkali a Substance will be deposited w^ch^ we shall find to be perfect Nitre. This Experiment may be repeated ad Infinitum by deflagrating y^e^ new formed mass of Nitre, and then by adding fresh portions of Acid to y^e^ Alkaline Residuum. now let us examine y^e^ properties of y^e^ constituent parts of Nitre. & then y^e^ Neutral w^ch^ these produce in

Combination.

Acid	Neutral	Alkali
Fluid	Solid	Deliquescent
Volatile	Fixed	Fixed
Corrosive	Mild	Corrosive
with water: Heating	Cooling	Heating
with Fire: Quenching	Excit. Inflam.n	Quenching.

The change of Qualities in these Bodies seems evidently to depend upon Combination & Seperation; tho' we shall hereafter perhaps meet with some Substances whose Qualities cannot be positively referred to these Causes; because y.e Matter dissipated or added may not be obvious to Our Senses. E.g. From 100 ℔ of Lead 110 ℔ of Minium may be obtained notwithstanding y.e parts which are dissipated in y.e Operation. here we Observe

a manifest Increase of Weight, without being able to discover any Addition whatsoever. But if our Proposition is found true in 99 Cases of 100, we may be allowed to conclude from Analogy y^{t} it takes place in the whole Truth. — Again if there be any Physical Elements, or inseeable Atoms, the Qualities of Bodies must depend upon the Composition or Resolution of these; & on this Hypothesis our Proposition will be founded. —

There may be Cases where neither a Composition of discrete, nor of concrete Bodies takes place, but only a Change in the Position of Parts; E.g. the Mephitic Air discharged & absorbed again in y^{e} Venous

Fermentation. yet even here we may Observe
a Separation of parts must precede the
change of their Position. —

From what has been said, the Definition
of Chemistry formerly mentioned, as
being a commonly received One viz: that
Chemistry is y^e Art of combining & Separ-
-ting Bodies, will appear very proper
but it is too general and not sufficiently
evident.

Having thus endeavoured to establish
our general Proposition, I shall proceed to
make some Remarks upon it as the Foun-
-dation of Chemistry. and w^th a view to y^e
this y^e better, I shall mention different

Hypothises concerning ye Origin of the Qualities of Bodies.

The Peripatetichs maintain ye Doctrine of Substantial Forms. Whence they derive ye Qualities of Bodies independant of their Texture & Combination of their Atomical parts. The W^ch Regard to ye Doctrine of Substantial Forms, it is faulty in this, that it infers ye Doctrine of Qualities. of which as they relate to Physical ~~Causes~~ Elements we must be extreamly ignorant, for the most subtile & minute Bodies may be shewn to be Compounds for the most part, & sometimes perhaps Decompounds.

I think every Experiment seems to be

most favourable to ye Doctrine of the
Corpuscularian Philosopher. for Exam
let us examin Nitre and its constituen
Parts, neither of which we can dissect
being Elementary Bodies. we find the
Acid fluid - the Nitre solid - the Alkali
dilaquescent - the Acid Corrosive - the
Nitre mild - the Alkali Corrosive &c. Hen
we see two Bodies Acid & Alkali produ
-cing a tertium Quid differing from
Both. now supposing ye Acid and
Alkali derived their Qualities from Subt
-tial Forms, can we conceive any Reas
why these Qualities should not be trans
to the Neutral.

upon the other Hypothesis we may

suppose that upon y^e addition of y^e Acid &
y^e Alkali an entire Change in y^e Arrange-
ment of their Parts takes place; from whence
it is easy to imagin new Properties may
arise in the Neutral. — in short all our
views lead us to speak of particular Qua-
lities in the particular Texture of y^e Mixts
in which they reside, unless we can separate
that part from y^e Mixt which gives it ~~the~~
particular Quality. for Instance wood is
an inflamable Body. its Inflammability
depending upon its Oil, which may be
separated from it. But this is only carrying
y^e Question one Step further. for we may next
enquire from whence proceeds this Inflam:y

in the Bil? In a Mixt however in which
y^e^ Qualities of the Ingredients do appear
we cannot always refer them to y^e^ Ingredi
-ents; for Nitre viz: is composed of two pow
-erfull Antiseptichs Acid and Alkali is
it self less so. Whereas One would suppose
the Doctrine of Qualities That it should be
more Antiseptic. It is certainly more pu
-table that y^e^ Antiseptic Quality of Nitre
does not depend upon y^e^ same Quality in
y^e^ Ingredients but upon y^e^ particular Com
-bination of them in forming y^e^ Nitre ie upon
y^e^ particular Texture of the Nitre. Again
if to a Quantity of the Syrup of Violets
turned red by an Acid, I added a Quan
-tity of the same turned Green by Vol: Alkali

provided y^e Acid and Alkali be sufficient exactly to saturate each Other / what will be the Result of this Mixture? — will the Mixture retain y^e Colour of y^e Ingredients & consequently be a Colour compounded of green and Red? — no — the Acid & Alkali mutually destroying each Others Texture, and y^e power by which they acted upon the Syrup, will suffer y^e Syrup to regain its former Texture, and consequently its blue Colour which depended upon its original Texture. ——

I come now in the next place to observe this ~~this~~ Corpuscularian Doctrine having its Turn been much Abused. many who

have espoused this Doctine have imagin
that y^e^ different Properties of Element
depended on y^e^ particular Size & Form
Each, and y^t^ therefore all y^e^ differ
Compounds resulted from a variety
Combinations of these Elements; as seven
Squares make a Cube - two Cubes a Pa
=rallelopiped &c. but this notion is liab
to many Objections which have give
occasion of Triumph to y^e^ Opposite Sect
it is not sufficient to suppose a Probabilit
of demonstrating y^e^ Existence of ~~such~~
such Elements or Corpuscules; but before
Conclusions can be drawn, Demonstrati
must be actually Obtained.

We shall adopt a more proper

Scheme to lead us to the Theory of par-
-ticular Qualities by considering ——

What Qualities belong to Bodies
as Aggregates, or to constituent parts.

What Disposition Bodies have to
unite w: Each Other: Thus Vitriolic Acid
and fixed Vegitable Alkali unite readily
w: water in a Separate State; but Vitrio-
-lated Tartar w^ch is formed of those two is
of difficult Solution: ——

The Qualities of Aggregates, and the
Modes of Aggregation consist in some Measure
between Heat, and the particles of Matter.
- it is even probable that all 4: different
kinds of Matter may be reduced to two,

viz: the matter of Heat, or an Elastic matter which seems to have a repulsive power, and 4th: kind of matter which has the power of Attraction, or perhaps we might go further, and suppose that it is perfectly inert.

I proceed now to another principal application of our proposition concerning the Operations of Chemistry viz: as it relates to the particular Operations.

The Combination of Bodies in Chemistry depends upon Attraction, & this 4th Only Property I can perceive in Bodies which does not depend upon their particular Texture. if we examin the

particular State of Bodies when Attraction takes place, we shall find it to be Fluidity. — Combination therefore depends upon Attraction, & this upon Fluidity, w.ch being liquid or Elastic is employed in Solution, Fusion & Exhalation.

The Term Attraction hitherto employed has been y.e Foundation of endless Debates among Philosophers. we shall first therefore endeavour to affix y.e precise Meaning that we would have it imply.

Every Tendency that we can perceive in different Bodies to approach Each Other, and then remain in a State of Coherence has been called Attraction, & of this there are several Species. a Stone dropt from

a Right endeavour to make its way to the Centre of the Earth, and ♃ Planets if not restrained by another Cause would drop into the Sun. This is called the Attraction of Gravitation.

The Tendency of a piece of Iron, and a Load Stone to approach each other is called the Attraction of Magnetism.

There is likewise an Attraction of Electricity which may be excited by various means, as by rubbing Glass Amber-Wax &c.

Two Globules of Quick-Silver upon a plane, or two Drops of Oil swimming upon Water being brought near each

other, shew a mutual Tendency to unite. wch Tendency is called ye attraction of cohesion, and this Term we shall have occasion to employ hereafter. —

with Respect to all ye modes we have mentioned, the Term attraction is only applied to signify ye genural Fact. this is ye Sense in which Sir Isaac Newton employs ye Term not saying whether ye Fact proceeds from some power exerted by ye Bodies attracted, or from their being pushed together by some external force. Some say this attraction is ye imediate act of the Creator, but this way of reasoning would soon put an End to all philosophical Inquiries. Thus when ye

Properties of the Air were not so well under-
=stood as it present, the established Doc-
=trine of Natures Abhorring a Vacuum
gave a considerable Check to y^e further
Inquiries concerning y^e Phaenomena of
y^e Fluid. — The Sense in which we now
always employ y^e Term Attraction will
be rather to express y^e Operation than
y^e Modus Operandi.

Chemical Combinations depend
upon y^e Attraction of Cohesion. The
Chemist only puts y^e Bodies he would
combine in a State most necessary for
the Exertion of this Property, wch generally
takes place in a certain Degree of Con-
=tiguity only. it seems to depend also

upon y^e figure of y^e parts of y^e Bodies
in Contact. this notion is favoured
by a simple Experiment. if you take
two Hemispheres whose Spherical Surfaces
are well polished, and press them strongly
together, they will adhere pretty firmly,
& their Adhesion will be in proportion to
y^e Smoothness of their Surfaces. but w^e
we have used our utmost Skill to give
two Substances a perfect polish, that y^e
greater Number of Parts may be
brought into Contact, we find y^e they
never will cohere so perfectly as when
a Fluid is interposed. this Circum-
stance is a further Confirmation of w^t

hinted at before, is y^t Fluidity is y^e only means of giving y^e Contiguity which is necessary for y^e attraction of Cohesion. But perhaps this Contiguity is not y^e only Cause of Cohesion. This is probably by something else disposing all Bodies solid and fluid to unite more or less w^th each other. May not Electrical Attraction serve this purpose? I cannot venture at present to discuss this Subject: these Facts however are well worth Observation that all y^e Liquids we are acquainted with are Non-Electrics and all y^e Solids (Metallic Substances

excepted) are Electrics per se when they are as free as possible from wet or moisture.

Seperation is modified by Elective attraction or y^e action of fire.

Elective attraction is Absolute or Relative single or double.

Absolute attraction is when a Body presented to two Others, attracts y^e One but refuses any union with y^e Other.

Relative Election takes place when a Body presented to two Others attracts y^e from both but has a greater Tendency to One than y^e Other. as an Example as y^e first we may

take Nitre & Camphor, and adding them to Water we shall find ye Nitre readily dissolved in ye Water, while ye Camphor will remain unchanged. if in the Room of Water we add Ardent Spirit the Camphor will be dissolved & the Nitre left entire. —

we may illustrate Relat: Attract: by ye following Experiment. To a portion of Camphor united w: Ardent Spirits let Water be added, the Spirit having a stronger Attraction to Water than to Camphor, will immediately let fall ye latter & unite w: ye former. A Consequence of Elective Attraction is, y: a Body cannot

be united wth two Bodies at Once, but
wth that Only wch it Attracts most strongly,
provided Likewise ye Body added strong-
:er Attraction wth Respect to One of the
combined Bodies than they have be-
:tween themselves.

The Effect of Elective Attraction affords
us a very useful Method of Obtaining
Seperations, as in ye Examples above or
in ye following. Let a piece of Copper
be added to a Solution of Silver in
Nitrous Acid. ye Copper having a
stronger Attraction to ye Acid than ye
Silver will precipitate it pure to ye Bottom
and unite itself wth ye Acid. upon ye same

Principles y^e Copper may be seperated by
y^e Addition of Iron.

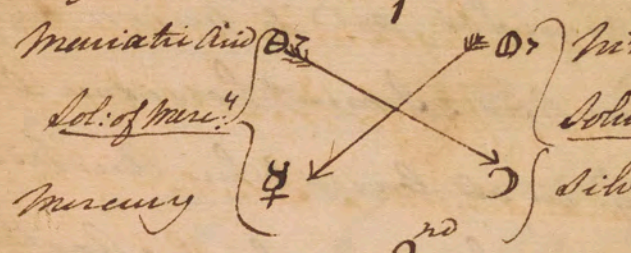
Single Elective Attraction takes plac
when a single Body is employed for
decomposing a Miat. E.g: y^e Silver is
seperated from Nitrous Acid by Copper

Double Elect: Attraction takes plac
when One Miat is employed to seperate
another. as suppose instead of employing
Copper alone for seperating Silver from
y^e Nitrous Acid, I had employed a Solution
of Copper in y^e Muriatic Acid, there
have been two new Miats produced.
One by y^e Seperation of the Silver from
y^e Nitrous, and its union w^th y^e Muriatic

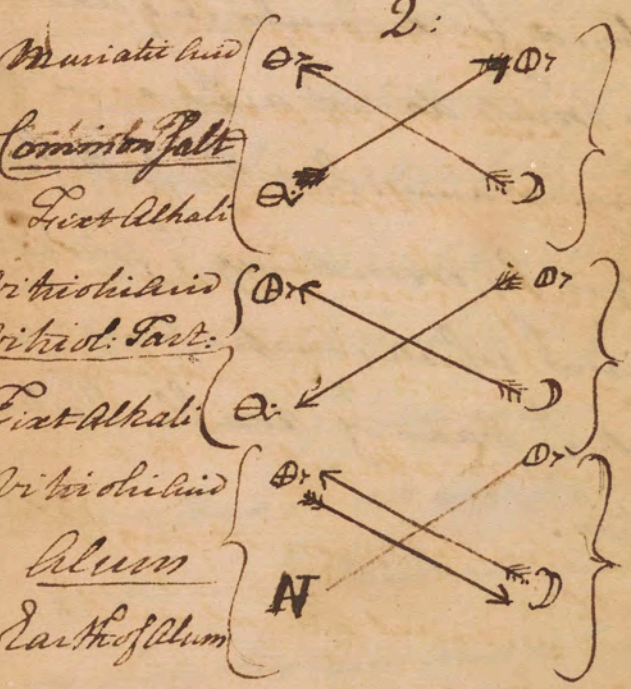
Acid, the Other by y^e^ Separation of y^e^ Copper from y^e^ Muriatic, and its Union with y^e^ Nitrous Acid. I must however Observe y^t^ in all Cases when One Mixt is employed for decomposing Another, two new Mixts do not arise as in the preceding Instance: but this will be best understood by considering y^e^ following Diagrams, which comprehend here-in all y^e^ Cases of double Elective Attraction.

The four Cases of double Elect: Attractions

1st



2nd



The Bodies w^ch stand upon y^e same side in each Digram are supposed to be united. in y^e first for Example y^e Bodies on One side denote a Solution of Mercury in y^e Muriatic Acid, and those on the Opposite side denote a Solution of Silver in the Nitrous. The Dart drawn diagonally from y^e Bodies on Opposite sides denote y^e y^e matter from w^ch y^e Dart proceeds attracts y^e to which y^e Dart is directed, more strongly than y^e Body w^ch it is at present united.

Thus (Dig: 1.) the ☉ attracts ☽ more strongly than y^e Mercury w^ch whilst it

at present combined, and on y^e other hand the ☉ attracts the ☿ more strongly than y^e ☽ w^h w: w: it is combined.

when ever we add two Planets whose parts have y^e same Relations to each other as do expressed in y^e two first cases a double Elective Attraction will always take plac between them, w: may be thus demonstrated. let y^e Attraction between the ☉ & ☿ be denoted by a. that between y^e ☉ & ☽ by b. let y^e new Attraction which takes place upon a mixture between y^e ☉ & ☽ be called c. & y^e between y^e ☉ and ☿ be called d. it is then evident from what has been said that c is greater than a & d greater than b.

that is y: Sum of the two new Attrac-
tions c + d is greater than y: Sum
of the Attractions a + b & opposite
thereto: in consequence of w: an Exchange
of parts will take place between y:
new Mixt Bodies: w: has been said
of the first will Obviously apply to
y: Second Case.

In Case 3: we cannot always
be certain before the Mixture, whether
a double Elective Attraction will take
place, since we do not know y Abso-
lute powers of Attraction exerted
between Bodies, but only their Relations
to other Bodies to prove this let the

Attraction between ☉r & ☉r/in Case 3d
: be called a, & the Attraction between
☉r & ☽ - be called b. let also e/y: two
new Attractions w.ch will arise from a
Mixture, be between the ☉r & ☉r &
the ☉r and ☽ be denoted by c & d. from
e/y: Position of the Parts we know y.e c is
greater than b, and d also greater
than b. Then is c + d greater than 2b.
But e/y: Attraction a is indeterminate
- we only know y.e it is greater than b
but are ignorant in w.ch Ratio it exceeds it
that is whether a be greater than 2b; this
can be determined by Experiments

plane, in most of ye. a is found to be less than 2b, and consequently a double Elective Attraction generally takes place in Case 3d. —

In Case 4th. we cannot determine be-
-forehand, whether a double Elective Attraction will take place, & indeed this is found by Experiments to fail much oftner than Case 3d. — Let ye. Attractions ☉ and ☾ Earth of Alum & ☉ and ☽ be called a and b, and ye. new Attraction between ☉ & ☽ be called c. we know from ye. Position of ye. Parts that c is greater than a, and also that it is greater

than b: but we can determine by Experiment alone whether a is greater than a + b, wch must be ye Case before an Elective Attraction can ensue. —

To assist ye Chemist in his Studies Dr Stahl and Sir Isaac Newton began ye Construction of Tables of Elective Attractions, together wth their Application; but Mr Geoffroy has published One of a considerable Length, wch I should here subjoin wth an Explanation, had it not been given already so fully by Macquer in his Elements of Chemistry. —

I could wish in this place to give a Theory of Elective Attractions, but y^e Subj: is so extremely Obscure that we can only expect to deliver a general view of it.

Throughout all Nature there seems to be an Elastic Repellent Fluid, w^ch is y^e Cause of all y^e Phanomena we Observe in Nature; more particularly of y^e various States of Aggregation in different Bodies. - every Body is surrounded by its own peculiar Atmosphere of this Fluid which grows more dense as it recedes from y^e Surface. This is Analogous to y^e Atmosphere of excited Electricity; which determines Bodies

Once got within its Sphere of Attraction
to the Surface of the Electric Body; it
is to be Observed y^t Bodies thus in Con-
tact w^th y^e excited Body remain some
longer some a Shorter time in Contact
w^th y^e Body Until they have got an Atmo-
sphere of their own; - Then they are
repelled 'till meeting w^th some other Bo-
dies they discharge their Electric Atmosphere
and are again attracted & repelled as before
- now let us try if from w^t has been
said we can form any Conclusions
concerning Solution & Mixture &
think we can, and am of Opinion that
those Bodies which when brought into

Contact have but an common Atmospheres as in a State of Mixture; whereas in Solution the particles of each Ingredient retain their proper Atmospheres, and are still capable of acting seperately upon other Bodies applied to them. very probably y^e^ pneumatic of fixed air has y^e^ power of rendering Bodies more or less powerful Attractants or Repellents; and hence it is perhaps y^t^ fluids having the greatest power of fixing air, and by y^e^ means of procuring a denser Atmosphere, are universally the greatest Solvents.

In all Cases, as we have already

said concerning Attraction in general
the Elective depends upon Fluidity
& therefore also upon Solution, Fusion
& Exhalation.

I said before that 4ly Separation of
Bodies was produced by two means.
1ly By Elective Attraction -
2do By the Action of Fire. —

I have finished wt I had to say of the
former, and shall now proceed to con
-der the latter. The Fire separates Bod
in consequence of their different Degre
of Combibity, and acts by Fusion, as for
Example. Fat requires a less Degree of
Heat for its Fusion than wax. - wax a

less Degree of Heat than Lead Lead than Copper Zinc. —

Fire also gives to many solid Bodies y^e State of Fluidity which we call Vapour. According as Bodies are more or less apt to fly off in this manner they are more or less Volatile. Whenever by means of Fire we thus raise Bodies in y^e Form of Vapour, the Operation is called Exhalation. Hence it appears y^t all y^e Operations of Chemistry whether of Combination or Seperation may be referred to Solution, Fusion and Exhalation. —

I shall next proceed to consider these Seperately, after having premised Some

Some things concerning y^e^ manner in which Fire produces its Effects.

The Actions of Fire removes y^e^ Particles of Bodies further asunder. Whence Fire is actually a Repellent power. all y^e^ Operations in Chemistry are performed by this Repelling power and y^e^ Attracting power. and perhaps we might say that all y^e^ Operations of Nature as well as of Chemistry are performed by the Agents. we do not know any Body in its utmost State of condensation, nor do we know any Body that is impervious to Fire. y^e^ Repelling Elastic Fluid or Ether

of Newton is universally diffused thro:
out all Nature, and constantly acting as
a Repellent power.

The Attractive and repelling powers
are constantly acting in Opposition to
each Other, and yet perhaps depend
upon y^e very same Other acting in
different Circumstances. If it will not
be difficult to admit this if One Postu:
lation be granted viz: that Inert matter
in a certain Contiguity of its Parts
has a power to diminish y^e repelling
power of y^e intervening Ether betwixt
its Particles. This admitted y^e Attractive

power Magnificently ye Effect of Repulsion
When two Bodies are in such a close
Contiguity as to diminish ye Repel-
-ling power of ye intervening Ether, if any
Power is applied to render ye Ether
active, the Bodies will also be again
separated by ye repelling power. Thus
Fire acts on Solid Bodies separating by
its repelling power their Parts, first bring
them to a State of Fusion, & afterwards
if more encreased dissipating them in
ye Form of Vapour. if all ye different pro-
-perties of Bodies depend upon their
= first States of Aggregation, their

Differences again depend upon Other.
and Other. and Inert Matter are hence supposed to be y^e^ Only Matter in Nature,
and y^e^ latter of One kind Only.

This Theory is not new. You may collect it from Newton's other works,
but more particularly from Dr Bryan Robinson's Treatise upon y^e^ Æther of
Sir Isaac Newton. it is y^e^ most plausible Scheme of Chemical Philosophy &
will at least check y^e^ false Theories of
y^e^ Corpuscularians. but in an Affair
of this kind y^e^ Difficulty is to find the
Cause of Elective Attraction, or why

Other does not admit of an equal Union
w: all Bodies. Having said so much
by way of Introduction, I now proceed
a seperate and more particular Consi
-deration of Solution, Fusion & Inhalation

Solution

When a Solid Body immersed in a Fluid
is diffused equably and uniformly
thro every Portion of y: Fluid, so as to
remain w: it in a fluid Form y: Operation
is called Solution.

The Solid Body is called y: Solvend
the Fluid in which it is dissolved is call
y: Solvent or Menstruum. The Term
Menstruum took its Rise from this Axiom:

Name, that y^e^ Ancient Chymists used
to allow a Menstruum for y^e^ Solution of a
Body imagining y^t^ this portion of Time
had a peculiar Effect upon y^e^ Solution.
I would use y^e^ Term Solution in a still
more extensive Sense, and apply it to y^e^
Mixture of Fluids w^th^ Each Other, for the
Term is equally proper if y^e^ Original
Composure or Texture of y^e^ Fluids be
broken down, and indeed we find it
is as common to Speak of y^e^ Solu-
tion of Essential Oils in Ardent Spirits
as of Camphor. But in y^e^ Case of Fluids
it may be often a difficult matter to de-
termine w^th^ is y^e^ Solvend, & w^th^ is the

Menstruum. The best way of distin-
-guishing them is this: When y^e Quan-
-tities of y^e Fluid are unequal. let y^e Lat-
ter be called y^e Menstruum, & y^e Smaller
the Solvend. When y^e Quantities are equal
we cannot always make a Distinction.

Chemical Solution must be distin-
-guished on y^e One hand from Diffusion
commonly called Mechanical Solution
and on y^e Other from proper Mixture.

When Bodies Specifically heavier than
a Fluid are immersed therein, they will de-
-scend to y^e Bottom but, y^e times of their
Descent will be reciprocally proportional
to their Specific Gravities. E.g: if we drop
a Ball of Gold, and another of Glass, the

Gold having y^e^ greatest Specific Gravity will descend in the least time. But a Body of any Specific Gravity may be suspended in a Fluid by Division; for if a Body be divided into a number of parts, y^e^ Quantity of Matter of Specific Gravity of each of those parts will decrease in a greater Ratio than their Magnitudes or Surfaces. Thus if a solid square Body contain 16 equal parts, or Cubic Feet, the superficial Contents of each of those parts will be one square Foot, and their solid Contents equal to 1 Cubic Foot. From this it is most evident that y^e^ Surfaces of these parts taken Seperately are exceeded by y^e^ Surface of y^e^ Mass before Division as 4:1, whereas y:

solid Contents decrease in y: greati
=tio of 16 to 1. The Suspension of Go
water when it is broken down or divi
into parts sufficiently minute, depen
upon y: foregoing principle. This is
I call Diffusion, and w: Others call
=chanical Solution, by way of Distin
from Chemical, which is y: intim
& minute union between y: parts o
Solvend and Menstruum which we
illustrate to you by y: following Exa

If One Grain of common Salt be
=solved in several Gallons of water,
least portion of this Solution w: w
can examin added to a Solution
Silver in Nitrous Acid will discover

much y^e^ Appearance and Effects of the Salt. as if the whole grain had been dissolved in a few Drachms of water. it is however very difficult sometimes to distinguish between Mech^l^ & Chemical Solution. the former will sometimes pass thro a Filtre without Sediment, wch has generally been thot a distinguishing mark between them. the most obvious Distinctions are, y^e^ Chemical Solutions are transparent, Whereas y^e^ Mechanical for y^e^ most part have a turbid Appearance, or that y^e^ former are permanent, the latter only temporary, or that y^e^ former takes place

only by bringing y^e^ B. dies into a prop
State of Contiguity. Whereas y^e^ latter
require Agitation, yet perhaps no
of those means of judging an entire
unexceptionable. —

Again. Chemical Solution strictly
speaking may be distinguished from
w: we call proper Mixture by se
=veral Circumstances. in Solution the
happens no other Change of Properties
the Reduction of the Solvend to a flu
Form, or rather the Division of it int
its minute integrant parts, as happen
in the Salt and water. In proper Mixtur
the Bodies do not retain the Properties
they had before such Mixture, but th

Result is w: we call a tertium quid, or a third Substance differing from those Ingredients w: compose it, & possessing new Properties. an Example of this we have in the production of a neutral from an Acid and Alkaline Salt. there may be however some cases wherein it will be difficult to distinguish them by this mark. in Solution there is no Generation of Heat, but I think that no mixture ever takes place without a Generation of Heat. another Distinction may be that two Bodies only can be united at y: same time (w: was observed when we mentioned Elective Attraction) whereas in Solution more than one Body.

may be united w.th a fluid at y.e same time. I am not certain of y.e Veriti-cality of this Remark, but in gene. it seems to hold true. —

The power w.ch Menstrua have of dissolving their Solvends is limited as well in Solution as proper Mixture. Thus a Quantity of water will take up half its weight of Glauber's Salt, 1/6 of Nitre, and 1/3 of common Salt. but whatever is added of y.e Above mention'd Salts to water, more than y.e proportion dissolved this additional Quantity of Salt unchanged to y.e Bottom. Whence a Fluid therefore has dissolved y.e greatest Quantity of a Solvend possible, that is

is said to be saturated. in Solution a
Saturation is generally effected by the
Solvend. with Regard to proper Mixture
Saturation takes place when y^e Bodies
are combined in such proportion as to
form a perfect neutral, but is not con-
fined to the Solvend, but may be effec-
ted by y^e Solvend or menstruum alter-
nately. E.G: if to Syrup of Violets be
added an Alkali the Colour is chan-
ged to a green; if to this Compound
a Quantity of Acid be added exactly
sufficient to saturate the Alkali or in
other words to form a neutral, y^e Syrup
will imediately recover its blue Colour,

but if Again you add to this satu-
-rated mixture a Quantity of Acid or
Alkali the Syrup will be changed in-
-sensably to a red or green as the Acid
or Alkali predominates. —

The Vessels commonly & most
properly employed in Solution are
Matrasses and Bolt-heads. When a
Matrass is closed by another smaller
& inverted, and joined to it, it is called
a Circulatory Apparatus or Pelican. The
former of these terms is applied, because
Vapours arising from a lower Vessel
condensed in the upper and return
Again to the lower by a continued

circulation. the best substance for making these vessels is glass, because it is least liable to be corroded by any menstruum, and at ye same time ye with proper management will sustain a very great Degree of heat. this quality is much encreased by a Spherical Figure, and uniform thickness of ye glass.

The Operation of Solution may be expedited by several means i: by the Division of the Solvend. it is evident that ye menstruum can act at ye same Instant of time upon those parts of the Solvend only wch are exposed to it, or in other words on its surface. now if

by any means y^e^ number of particles immediately exposed to y^e^ menstruum in any given Quantity of the Solvend, be encreased, or w^ch^ is y^e^ same, y^e^ Surface of the Solvend be encreased, it will be evident that y^e^ time w^ch^ y^e^ menstruum will require to dissolve this given Quantity of the Solvend, must be proportionably lessened. for y^e^ menstruum act as forcibly upon y^e^ greater as the smaller Surface, and consequently in a given time produce a greater effect. That this Increase of Surface of the parts exposed may be effected Division will be obvious from the principles mentioned on y^e^ subject of Mechanical Solution. 2^nd^ly

2ndly By the Agitation of the containing Vessel. The chemical Solution is performed merely by adding the Bodies to each Other; yet we may expedite it by Agitation, because by this means a greater portion of the Menstruum is applied to y^e^ Solvend and vice versa at y^e^ same time. E.g. 1 Oz: of Wine poured gently upon Water will swim on y^e^ Surface without any Appearance of Union. But Any Shake of y^e^ Vessel will soon ultimately diffuse them together, they they will remain united for Years. if 1 Oz: of Salt be added to a Gallon of Water, it will not dissolve in a

considerable time, but if y^e Vessell be
agitated it will dissolve in a short time
Mon: Lagnard has invented a Machine
for promoting Solution. I suspect
y^e advantages arising from it will not
be so great as he imagins. The one
advantage will be y^t we may dissolve
Bodies in y^e Cold, which is a matter
of great Importance as Heat changes
considerably y^e Properties of many Bo-
dies.

3^rdly By the Application of Fire
when I was treating of Saturation,
Observed y^t any particular Menstruum
would only saturate a certain pro-
portion of the Solvend, & y^t varying in

diffrent Bodies. I ought however to have
observed y^{t} y^{e} Temperature of y^{e} menstruum
ought to be precisely y^{e} same in every Experim^{t}.
for y^{e} power of a menstruum encreases
very much by y^{e} Application of Heat, so
y^{t} water w^{ch} in y^{e} Ordinary State of the
Atmosphere dissolves only $\frac{1}{6}$ of Nitre will
when boiling dissolve a Quantity exceeding
greater. The Heat may also act as a
Repellent in separating y^{e} parts of y^{e}
Solvend, but of this more hereafter.
With Regard to y^{e} Application of Heat
it may be done two ways, either in
close or open Vessels. in y^{e} latter Practice
for Solution the Application of Heat is
much limited, for all Fluids in a certain

Degree of Heat above w: is called the boiling point, after w: they cannot possibly be rendered hotter: but if more Heat be applied they fly off in vapour: thus Rectd Spirits boil at 176° of Farenh: Thermometer. water at 212°: but Bl: w: suffers some Resolution by boiling requires a much greater Heat. the boiling point of Fluids varies as the pressure of the Atmosphere. Baron Montesquieu who lived near the Pyrenees tried y: Experiment at various Heights on those mountains, found y: as he ascended to diff: Heights when y: pressure of y: Atmosphere was

consequently less. ye heat necessary to boil water became much less than 212°, & e contra y: y: boiling point encreased as he depressed till at ye Bottom it arrived again at 212°.—

About 80 Years ago was contrived an Instrument called Papins Digester. wch is a strong cylindrical Copper bepd, wh a Cover fitted so accurately wh a screw and lever as entirely to exclude ye external Air. The Spring of ye Air in this bepd being encreased by heat may be made to act wh a force extremely great, wch will consequently enable ye contained Fluid to bear a much greater degree of heat, than it would have done in ye Open Air;

the Spring of y^e Air may be so encreas
as to ~~burst~~ break y^e strongest Ves
— to prevent w^ch there is generally a
at y^e Top covered w^th a Valve. This va
must be compressed by such a weigh
as will give way to y^e force of y^e Elast
Air, before the Vessel is burst. Papin's
are usually made of Copper, or some
Other metallic Body, but these are
inconvenient as they are apt to be
=roded by most saline Substances. Th
Inconvenience has luckily occasioned
Invention of the Glass Digestor. Whic
w^ch this loss is not so great as in Pap
yet it is sufficient for most purposes. T

boiling point of water is perhaps y^e^ greatest Heat to w^ch^ we can expose it w^th^ safety; but even this enables us to give Ardent Spirits w^ch^ in Open Vessels vaporates at 176°: the Heat of boiling water w^ch^ as we mentioned before is 212°. a Thermometer might be inserted into this Digestor for regulating y^e^ Degrees of Heat. it is supposed y^t^ Solutions made in the Digestor differ from those made in Open Air, as y^e^ former have generally a turbid Appearance; & from hence it diminishes y^e^ Elegance of the preparation; whether it improves its active Qualities I shall not here determine

Solution is promoted

2dly: By the Application of Air. Anim
Philosophers have supposed y: wate
the primum Liquidum, or y: primary
Cause of the Liquidity of all Bodies. In
Speculations & Experiments have mad
rendred it extremely probable y: Air is
a principal Agent in giving Bodies th
-quidity. if Water saturated w: Nitro
be put under a Receiver when the
Air is exausted a portion of y: Nitr
will be precipitated. When Acids act
upon Alkalies or Metallic Substan
-ces a great Quantity of fixt Air is ex
-tricat

it is highly necessary to ꝑ Solution, that
this Air be absorbed by the external Air, wch
readily takes place by an Elective Attrac-
tion between ꝑ fixt, and ꝑ: common
Air, and between ꝑ Solvend and Men-
struum. in Consequence of this the
progress of the Solution will be much
impeded by excluding ꝑ: common
Atmosphere. Eg: Copper put into vol.
Alkali if kept from the external Air
will not be much affected by it, but if
free access of the common Air be allow-
ed the Alkali will quickly dissolve it.
If after the Solution is completed it
be enclosed in a vial from wch ꝑ Air is

entirely excluded the Copper in proces of
time will be precipitated from y^e^ Sol.
Alkali. Besides these, very numerous
Facts might be adduced to show how
extremely necessary the Air is to y^e^ pro-
-gress of Solution. One Affair I shall
mention w^h^ occurs in our Kitchen
it is when any Corrosive Body is kept
in Copper Vessels for a long time y^e^
part of the Vessel only is acted upon, where
there is Communication between y^e^
Air - the Fluid contained - & y^e^ Vessel
wit round the Edges of the Fluid.
In the Conduct of Solution it is proper
to avoid Effervescence & Dissipation

have already Observed that some Bodies are extremely Volatile, so as to be dissipated with a very small Degree of Heat. to avoid this, it is necessary to use close Vessels, and apply very little Heat. —

Effervescence is that intestine Motion which arises upon the Mixture of some Bodies, from a sudden Extrication of their fixed Air, and the Reduction of it to an elastic State. That Effervescence depends upon a Separation of Air, is evident from this Experiment. Tie a Bladder loosely over the Mouth of a Vial containing Iron Filings; then add a Quantity of the Vitrious Acid thro' an Aperture in

the side of the Vial, and we shall observe
(if the Aperture be closed) 4ly: the Bladder
will be distended with Air as the Effer-
-vesce goes on, 'till it burst if a vent is
given. — now this Effervescence is to
be either avoided or moderated upon se-
-veral Accounts, 1ly: It is in some Cases
so violent as to rush Over the Vessels if
Open, and burst them if closed. 2dly: The
Vapours arising from many Bodies
are so deleterious as oftentimes to
bring an instant Death to Animals who
breath them. 3rdly: those Vapours are some-
-times very inflamable, so that if they
come in Contact w.th burning Bodies they

immediately take Flame, and explode w: great danger to the Operator, if they are very copious. we may see an Example of these inflamable vapours by applying a Flame to the vapour of Vitriolic Acid, and Filings of Iron during their Effervescence.

I shall now go on to mention the best means of avoiding Effervescence.

1st: By adding the Solvend in small Quantities; for the Degree of Effervescence is generally proportional to y: Quantity of the Bodies added. we must however observe to let y: Effervescence of y: first Quantity cease before we add a second.

an Exception to this general Rule
-curr in the Mixture of Nitrous Acid
Mercury in w^ch case the Solvend is al
to be added at Once. This is readily a
-counted for, because Mercury when ap
-plied to an Acid in the cold does not
afford much Effervescence, but as y^e
Heat in which the Mixture is made
encreases, the violence also of the Effer
-vescence will encrease in a great pro
-portion; now if the Mercury be applied
gradatim, in the common way the Heat
excited by the first Addition, would encrease
the Effervescence of the second, & this y^e
Windor. yet in the Case of Mercury we

might add it gradatim provided the heat excited by the first, subsided before a second Addition was made. This practice however would be very tedious.

Another Method is by performing y^e Operation in close vessels excluding the external Air, w^ch as it promotes the Solution of Bodies will consequently encrease their Effervescence; but this Operation is attended w^th great Hazard of bursting the vessels. In this practice the circulatory Apparatus which gives Room for the Escape of Vapours, or a Matrass w^th a loose Stopper are y^e Safest and most convenient vessels.

Mr. Geoffroy however has invented a

Method of avoiding the Effervescence
them, by interposing a Quantity of Oil
between the external Air and y^e Menstru
— Thus upon the a Quantity of Oil floats
upon the Nitrous Acid, if again we take
Bits of Iron previously dipped in Alkohol
that y^e Oil may not adhere to them, and
drop them into the Acid an Effervescence
will ensue, but not near so violent as
if they had been mixed without the Interp
-position of the Oil i.e. in the Open Air.
in some Solutions also the Effervescence
is different as we add y^e Menstruum to
the Solvend, or the Solvend to y^e Menstruum.
Thus in a Solution of Alkohol in

Nitrous Acid, the Effervescence is much greater when we add y^e^ Alkohol to the Acid, than when we add the Acid to the Alkohol. This Phanomenon is explained by the Action of the Air, for in the latter case the Acid being heavier than the Alkohol sinks to the Bottom, whereas in the former the Alkohol swims at the Top, and is more exposed to the Air.

We must be careful to distinguish betwixt the intestine Motion named Effervescence, and y^e^ of Ebullition and Fermentation.

Ebullition is properly applied to that Motion only which is excited in Fluids

left till they arrive at y: boiling point.
That Motion only is called Fermentation
w: has an assimilating power, i.e. when
the properties of one of the Bodies that
is added is rendred the same as the
Other. we have an Instance of this
in Leaven; a small Quantity of which
added to a larger Quantity of Dough
leavens the whole, or assimilates it to
its own Nature. —

Solution acording to certain
Differences in the practice is named Macer-
=ration, Infusion, Decoction, Digestion,
Circulation, Deliquescence or Amalgama-
=tion. Maceration & Infusion

do often promiscuously employed to signify the same thing, but with great impropriety, for maceration properly is when we employ a Heat less than the boiling point. —

2nd Infusion is when a Fluid is pour'd on at the boiling Heat, and then suffer'd to cool. —

3d Decoction is the continued Application of the boiling Heat.

4th Digestion is Heat continually applied to a Fluid without boiling. if the Heat is less than the boiling point it may be performed in Open Vessels, if greater in close Vessels, to prevent boiling, and in

this Case it is most properly called Diges-
=tion.

5ly. Circulation is when the Vapours ariſ-
from the Veſſel are condensed by Anoth-
& by some Communication return
to ye: first in a liquid Form.

6th. Delaquescence. the Air is always re-
=plete with watery Exhalations, wch: com-
Bodies are much disposed to Attract &
them run into a fluid State. when
this Procefs takes place it is called De-
=liquescence. the Procefs of making Bl.
Myrrh: & Deliquium comes properly un-
=der this Head. —

7ly. Amalgamation. this Term is applied

July to the Solution of Metals in Mercury.

Having now considered y^e^ means of combining Solvends w^th^ their Menstruums, Let us now take notice of the means by w^ch^ dissolved Bodies may be separated from their Menstruums. This is done by Precipitation - Chrystalization & Evaporation.

1^st^ Precipitation depends upon Elective Attraction as y^t^ it is a Species of Solution. When to two Bodies united by Elective Attraction a third be added w^ch^ unites w^th^ one, & consequently separates the other, y^e^ Process is called Precipitation, & y^e^ Body added is called the Precipitant.

There are only four different ways of
Precipitation. —

1st: Of the dissolved Body alone
2nd: Of the dissolved Body and y.e Precipitant
3d: Of the Menstruum alone.
4th: Of the Menstruum w.th y.e Precipitant

Example of the 1st Case. — If to a Solution
of Silver in Nitrous Acid be added Filings
or Plates of Copper, the Silver will be pre-
-cipitated to y.e Bottom in y.e form of
White powder, as fast as y.e Copper dissolves
because the Acid has a stronger Elective
Attraction to y.e Copper than to y.e Silver

Examp: Case 2nd: If to a Solution of Silver
as before we add y.e Muriatic Acid it will
attract y.e Silver from the Nitrous, and

uniting w.ch it fall to the Bottom in
a solid Form, for the Muriatic Acid
does not dissolve Silver, but only corrodes it.
Exampl: 3.d Case 3.d If to a Solution of Gold
in Aqua Regia we add q.y: Vitriolic Ether
the Gold will be attracted by, & suspended
by the Ether while its former menstru-
um falls to the Bottom.
Example of Case 4.th If to a Solution of
Camphor in Alkohol we add common
water, the Alkohol and water will unite
and fall to the Bottom, while q.y Camphor
will swim on their Surface.
By the third Experim.t we may

determine the purity of Gold w^ch^ is great
=racy, for if any Copper be mixed w^th^ it
Aqua Regia will keep the Copper
=solved, and by that means appear
more or less of a blue Colour according
to y^e^ Quantity of Alloy.

In the two first of the foregoing cases
the falling Body is called y^e^ Precipitate
the Magistery or Calx.

There may be Instances w^ch^ cannot w^th^
strict propriety be referred to any of y^e^
former cases. E.g. When Silver is added
to a Solution of Gold in Aqua Regia, it
attracts, and unites with the Muriatic

luid of the Aqua Regia, in Consequence
of wch the Gold, and ye remaining part
of the Aqua Regia viz: the nitrous luid,
will continue Separate and unchanged.

If water be added to a Solution of Me-
tallic Substances in luids, a Precipitn
of the M: S: ensues. Whether ye luid
has a Stronger Attraction to ye water
than to ye M: S:, or whether ye Qualities
of the luid wth Relation to ye M: S: be
changed by Dilution, I shall not here
take upon me to determine.

Before we Leave this Subject of
Precipitation, I shall add some
genral Directions for ye Practise of it.

When Precipitants are used it is necessary
in general to dilute the Solution w: water
& when Precipitations are effected by water
alone it must be added in large quan-
-tities. by this Dilution we cause a
perfect Separation. There are some excep-
-tions to this Rule perhaps that are
not taken notice of by Chemists. If
any Substance precipitates in particles
of great minuteness, these may be per-
-manually diffused for a long time, by
a large Quantity of Solution, & Separation
may be rendered more tedious, if not
impracticable. in Precipitations
Effervescence is to be avoided for y same

Reasons, and by ye same means we
mentioned when treating upon ye Subjct.
We must not add a greater Quantity
of the Precipitant than is just Suffi-
cient for Our Purpose, for many Sub-
stances if added in a greater Quantity
than is requisite for ye Precipitation of ye
Solvend will occasion ye Menstruum to
redissolve the Precipitant. E.g. If to a Solu-
tion of Silver in Nitrous Acid diluted, be
added the volatile Alkali gradatim to
avoid Effervescence a Precipitation will
ensue. We must continue to add
Gradatim so long as any Milkiness

appears. but if after this the Addition
continued to a certain Degree, y^e^ precip
-tated powder will be again taken up
and the whole become One transpar
Fluid. —

Edulcoration. when a Precipitant ha
a part of the Acid which had formerly
dissolved it, still adhering to it, y^e^ washing
of that w^th^ water is called Edulcoration.

Corrosion. when a Metallic Substance
can be combined w^th^ an Acid in a dry
Form only the Combination is calle
Corrosion.

In most of the Practices of Solution
there is occasion for Colature & Filtration
— the first of these Terms is applied to

straining thro coarser Filtres, as the Hair-Sieve - woollen Cloaths &c. Mulla-
-tor is chiefly used for y^e^ finer Filtres as Paper &c. The most convenient kind for this purpose is Blossom-paper, the Filtres of which are longer than of common Paper. —

In Opposition to Solution is Coagu-
-lation, or the Practice of reducing Fluids to a solid Form. —

The Action of Fire has y^e^ Effect of co-
-agulating Animal Fluids, as we see in the Whites of Eggs, and many other Cases.

Sometimes dry Bodies ~~attract~~ coagu-
-late

Fluids by entangling them in their pores and preventing them from moving freely. E.g: If to an English pint of common water, be added a tea spoon-full of Salop (viz: is a Root brought to us from the Levant, in fine powder, the whole will shortly become a thick Jelly. Most Instances of Coagulation are only the Effect of Precipitation, as appears from adding Alkohol to a Solution of Glauber's Salt in water. But in this Case it only happens in Consequence of Agitation, for if the Alkohol be added gradatim, & or the Solution suffi-

to remain at rest for sometime, even after it has assumed a solid Form, the Alkohol will attract the water to the top, and the Salt will be precipitated to the Bottom. —

Of Fusion. —

Before I speak particularly of Fusion, or the Reduction of solid Bodies to a fluid Form by the Action of Fire, I shall say something concerning y^e^ Theory of Fluidity in general. —

The Ancient Philosophers Observing y^e^ all Fluids as Oils, Juice, And^a^ Spirits and even Mercury received water into their Composition, concluded that

Water was y^e^ primum Liquidum or universal principle of Liquidity. This Reasoning however is easily overthrown by considering that water is not tenacious of its Fluidity and y^t^ many solid Bodies mixed w^th^ water encrease its power of retaining Fluidity. —

The Corpuscularians say y^t^ the Fluidity of water depends upon y^e^ Spherical Figure of its Particles, w^ch^ slide easily over each other, and yeild to the least pressure. This Opinion is false & improbable, for these Spherical Atoms were never proved to exist, & even granting the Existence of such Particles, it is

to me altogether inconceivable how by
the Diminution of one or two Degrees
of Heat in the Thermometer, these
Particles can be so entirely deprived of
their Figure as to form a Mass, hard
and solid, or how by restoring
the Heat they can regain their Spherical
Figure and instantly become fluid.
We know no Body in nature that
will not assume a fluid Form under
a certain Degree of Heat, nor is there
any Body in nature which will not
under a certain Degree of Cold assume
a solid Form, however often we meet
with it in a fluid state. Since it

appears y: Fluidity is not essential to
any Body in particular. I shall
therefore when I mention Fluidity
understand by it "a certain Relation
of Bodies to Fire" — which seems to be
the sole Cause of Fluidity. Solidity and
Vapour in Bodies of Bodies seem all
to depend upon the State of Elastic Æther
upon their Surface, & within their Pores.
When the Repulsion of y: external Æther
prevails over that of the internal, the
Body is preserved in a State of Solidity
when by the Action of Fire the Elasticity
of the internal Æther is much encreased

as exactly to counterballance &c. &c. &c.
the Body is reduced to a State of Fusion.
but if the Fire be still further encreased, the internal Attraction acquires a still stronger repulsive Power, and becomes superior to the external, then the Body flies on in Vapour, each particle being as it were surrounded by a repellent power of its own.

Fusion combines Bodies by what has been called dry Solution, & separates by Elective Attraction or the Action of Fire in different Degrees on different Bodies.

When an Elective Attraction takes place under Fusion the Operation is

named a Precipitation by Fusion, or Precipitatio fusoria, and in the Case of Metallic Substances that parts separated are named Scoria or Regulus. The word Scoriæ was formerly applied to the gross part only which is thrown out in the Precipitation of Antimony, but it is used to signify all the vitrified friable matter that is thrown off by Metallic Bodies in a great Degree of Heat.

The pure Metalline part of Antimony concretes somewhat in the Form of a Crown, & hence it received the Name of Regulus or little King. This Term

however is now applied to y.e Metallic
part of all Substances.

As an Example of this kind of Separation
viz: by Elective Attraction. Let us exa-
mine the Process of purifying crude
Antimony. This Substance is compos'd
of Sulphur and a pure Metalline
part called Regulus. it is required to
seperate the Sulphur from y.e Regulus.
to effect this we must find a Substance
which has a stronger Elective Attraction
to Sulphur than the Reg.s of Antimony.
among such Substances we shall
find Iron or Tin. let us therefore put
thin plates of Iron into a Crucible in

a Melting Furnace w.th the addition of
little fixt Alkali to promote y.e Fusion
When the Crucible is red hot, putting
Antimony. let the whole be fused toge
-ther. After this removing y.e Crucible fr
y.e Fire, suffering it to cool, we shall find
the Regulus at the Bottom, and the
Sulphur united w.th the Iron in Scoria
at the Top. —

As an Example of the second kind of
Separation viz: by the Action of Fire,
we apply a mixed mass of Lead & Copper
to a Heat just sufficient to melt the Lead
in Consequence of this the Lead will all be
fused, & run Out while the Copper will

remain unchanged.

The Fusion of Bodies may be consi-
-dered as of two kinds; the One when y^e
Body melted suffers no Change, but y^e
by the Action of Fire, from Solid it
becomes fluid, and upon removing y^e
Fire concretes into y^e same Form as
before. The Other Case is, when y^e Body
melted suffers such a Change, that upon
cooling it does not concrete into the
same Form as before. Of this y^e most
noted Instance is Vitrification.

The Fire separates Bodies under Fusi-
-on by acting upon y^e common Fusi-
-bility or by acting upon y^e Viscidity.

upon the first depends Eliquation and Congelation, upon the second depend Scorification and Cupellation.

When solid Bodies varying in their Fusibility are combined, & we seperate them by that means, as in the last Example of Lead and Copper, y^e Operation is named Eliquation.

The seperation of fluid Bodies by carrying the Heat below y^e freezing point or in other words by encreasing y^e Cold is called Congelation, and is just the Reverse of the former, tho both depend upon the same Principle, Viz: y^e different Degrees of Heat, and the different Fusibilities

of Bodies. E.g. If a Degree of Heat below 30° in Farenh^t be applied to a Mixture of Alkohol and water, the water will soon be converted into Ice, while y^e Alkohol on Acc^t of its greater Fusibility will remain fluid ~~above~~ and pure.

If Lead be continued on y^e Fire after Fusion, a thin pellicle will appear w^ch will break and retire to y^e Edge; this will be succeeded by a second &c — till the whole mass be converted into thin Pellicles or Scoria. This Operation is called Scorification, It is much expedited by a continual Blast of Air upon the Metal. ——

If these Scoria be exposed to a greater Degree of Heat, they turn of a dusky brown Colour, and after y^t they become Red-Lead or minium. if the Minium is fused it will concrete into vitrified Mass. this latter Process is called Vitrification. the minium when in Fusion is of so subtile a nature, that it pervades y^e Pores of almost any Vessel, hence it has been a Desideratum among Chemists to invent a Substance y^t would contain it.

Lead is not only of itself readily vitrified, but it also disposes various

Other Bodies to Vitrescency, as Earths, and all Metallic Bodies except Gold & Silver. Hence if these be fused w.th Lead it separates in the form of Scoria, accompanied w.th all the heterogeneous matter of the Gold and Silver. —

When a Metallic Substance has been deprived of its metallic Form, & is by certain means under Fusion brought back to it again y.e Operation is named Reduction. — This is effected by letting the changed Substance come in Contact w.th Vegitable Coal in Case of Vitrification. E.g. if the Minium of Lead be fused w.th a Quantity

of Charcoal, it will recover its for-
-mer Metallic Appearance. —

The Vessels most commonly employ-
-ed in Fusion are Crucibles. Those
were made formerly in Hesse of a
particular kind of Earth, and were
named German Crucibles. but they
are greatly inferior in Strength &
Fixity to those made now in Britain
of black-Lead. — it is necessary in
many Operations to prevent the
Contact of burning Fewel. this is
conveniently done by stopping the

Crucible w^ch a smaller inverted.

In Scorification are employed Tests. Cupels, and Muffles. the Test or Cupel, w^ch is smaller, and more used at present, is put into a Muffle to prevent y^e Contact of the Fire w^ch is a necessary Caution in these Operations. —

Of Exhalation.

When the parts of Bodies are separated w^ch at present cohere, and fly off in the Air, such Bodies are then said to be volatilized, or exhaled, and y^e Operation is named Exhalation. —

The principal Causes of this are as

follow; either when the parts being Specifically lighter than Air are buoyed up thereby, or 2dly the Air acts upon Bodies as a Menstruum, & by that means carries them off. or 3rdly when the parts are driven off by y Force of Fire. The Distinction between the first and last is extremely nice; for the Fire acts as well by rarefying Bodies as by rendering them more Elastic.

Exhalation is various, as it is guaged for Obtaining the - Fine parts

Fixed parts

{ of Fluids by Evaporation
{ of Solids by Ustulation & Calcination

the Volatile Parts

{ in a fluid Form by Distillation
{ in a solid Form by Sublimation.

of a like nature w.th these two last, but somewhat diffirent in the Manner of Operating are Cementation and Inspissation.

When in seperating the volatile parts of Bodies we apply them at the same time to other purposes, the Operation is called Cementation, from a Resemblance it is thought to have to the work of Masons. E.g. If I have a Compound of Gold & Silver I can by the same Operation obtain a

Solution of the Silver and a Seperation of it from the Gold; lay a Stratum of green Vitriol and Nitre upon the Bottom of your Vessel, and over this a plate of y^e^ mixed Metal. Let this be repeated 'till the Vessel is full, then lute it, and apply it to y^e^ Fire. in this Operation the Acid of the Vitriol unites w^th^ the Alkali of the Nitre; - the Acid of the Nitre ascending in Fumes unites with every portion of the Silver of the mixed mass in the form of Corrosion, w^ch^ may therefore be swept quite clean from the Gold.

When Nitre is applied to burning Fuel, its Acid is exhaled, and y^e^ Alkali remains behind. this is an Instance of Inflamation or the Application of Bodies immediately to

the Fire. under this is comprehended 2d: has been called the Sublimation of Geber.

I now proceed to consider 4: Operations belonging more particularly to Exhalation.

Evaporation is practised on Fluids chiefly for obtaining the fixt parts, while the volatile are suffered to fly off. According to certain Circumstances of the Subject is named Inspissation or Extraction. —

When a Fluid contains a number of Heterogeneous Bodies more fixt than itself, if we evaporate this considerably 4: Heterogeneous parts will render 4: remaining Fluid thicker, whence 4: Operation has been named Inspissation. —

When we practise on Animal & Vegitable Substances in Order to Obtain their virtues by Solution we must use a large Quan- -tity of the Menstruum. this however oftenrenders the Preparation too bulky, so y: we must reduce it by Evaporation, and this Operation has Obtained y: name of Extraction. —

When Bodies suspended in a Fluid by Solution are made to Subside, they com- -monly assume the Form of Crystals: hence the Term Cryptalization. this is almost universally applicable to saline Bodies only; I do not say wholly, be- -cause, so far as we know it may be

practised upon some other Bodies. nature indeed promotes it in all Bodies.

2 Crystalization depends sometimes upon diminishing the Heat. for if boiling water, saturated with Nitre, be set to cool, we may observe the Nitre crystalizing as the Heat decreases. but as it more generally depends upon diminishing y^e^ Quantity of the Menstruum by Evaporat^n^ it belongs properly to this Head.

3 Evaporation is carried on by y^e^ Action of Air or Fire, or by the joint action of both. The Air serves not only to buoy up the parts seperated by Fire, but acts also upon many Bodies as a Menstruum, and y^t^ like the Other

Menstruums in proportion to its Heat as I shall endeavour to prove hereafter.

It may be useful now to add some Rules for the practice of Evaporation. In Evaporation we are liable to many Inconveniences from an Excess of Heat, for the parts of some Bodies differ so little in their Fixity, that without great Exactness the Whole will be dissipated; or when by Inhalation is performed too rapidly, the light fixed parts may be carried off by the volatile, or they may be entirely changed and contract an Empirreuma, to which all Animal and Vegitable Substances are

noxious from too great Heat. to Obviate those Inconveniences & to lessen y^e^ Labour of the Operation, some Medium is interposed between the Subject & the Fire, w^ch^ will bear a slow regular, and determined Heat only, for this purpose Fluids w^ch^ receive no Heat after the boiling point are most proper. in different Cases we ought to employ Fluids of different Fixities; for some Substances undergo a considerable Change of Qualities, even from the Heat of boiling water.

The Water should be continually stirred 'till it boils, and then y^e^ Ebullient

Motion will answer the purpose, & thus
the more solid parts lying in Contact with
the Bottom of the Vessel, may become Im-
-pyreumatic.

The Surface of the Fluid Ought to be as
much encreased as possible. for Evapora-
-tion is found to go under a given Degree
of Heat in proportion to the Quantity of
Liquor exposed to the Air. —

The late ingenious Dr. Hales invented
a Method of Throwing fresh Air continually
upon the Evaporating Liquor, thereby very
much facilitating the Operation.

Ustulation. When a Body exposed
to the Action of Fire, after a Dissipation

of its volatile parts, retains its Original Texture, and some Degree of Firmness, it is said to undergo Ustulation. But if under this process the Body loses its Texture, and falls into a powdery State, the Operation is called Calcination.

The Calcination of many Bodies evidently depends upon a Dissipation of their volatile parts, but the Calcination of Metals, and other Bodies which acquire an additional weight cannot be explained by any Hypothesis yet advanced.

In the practice of Calcination we must observe whether our Subject

calcines best in a solid or fluid Form
Lead is most readily in the Latter. Iron
Copper &c in the former State. —

Distillation

This is distinguished according to the
Subject, into Simple Distillation (im:
= properly called the Chemical Analysis)
and Distillation w:th addition.

I have little to say on y:e Subject of
Simple Distillation, having treated
Evaporation so fully. it depends chiefly
on the Action of Fire; for y:e small
quantity of Air. contained in y:e distilling
Vessel is so diminished by Rarefaction,
as to produce no desirable Effect in the
Operation. hence the Reason why an

Increase of Heat is necessary towards the End of the Process, when the 4th: contained Air is almost entirely driven out.

Distillation 4th w: Addition is a more complex, and a more useful practise than the former. The Addition is made for several purposes. 1st: by Elective Attraction for letting loose a volatile part. Thus in distilling the Acid from Nitre, we add the Vitriolic, this having a stronger Attraction to the Alkali of the 4th: Nitre than its own Acid, seperates the latter, in w: State it is easily obtained Alone. — 2nd 4th by Elective Attraction for fixing one of two volative parts. — Thus Sal Ammoniac is a Neat com-

-pound

of Muriatic Acid, and Volatile Alkali, by adding Therefore y^e^ Vitriolic Acid, we fix the Alkali, and are thereby enabled to seperate y^e^ Muriatic Acid by Distillation, or again by adding a fixt Alkali we fix the Acid, & seperate the Alkali. — 3^dly^ by Elective Attraction for seperating a fixt part, by uniting with this, for volatilizing it. Thus crude Antimony is composed of Sulphur & a Metalline part. by y^e^ Addition of Muriatic Acid, the Metalline part unites w^th^ it, & becoming volatile rises w^th^ it in Distillation in y^e^ Form of Butter of Antimony. at y^e^ same time

we add Mercury to fix the Sulphur, or we may add the Muriatic Acid & y^e^ Mercury united in y: Form of Corrosive Sublimate.

4^ly^: By uniting w^th^: the Whole a Mixt for volatilizing it. Thus by adding Copper or Iron to Sal Ammoniac we encrease the volatility of both Ingredients. —

5^ly^: By dividing an Aggregate for preventing its Fusion, and thereby favouring its Resolution. Thus if Brick-Dust or ~~powdered~~ dried Clay be mixed w^th^: powdered Nitre its Fusion is in some measure prevented, and its Resolution considerably expedited. The Ancient Chemists knew the Advantage of this Practice, tho they were ignorant of y^e^ Cause.

6th By dividing an Aggregate for preventing Intumescence, & thereby favouring the Separation of the parts resolved. Air is an Ingredient in all Bodies, and being set at Liberty by Distillation, rises in Bubbles w: if the Liquid be viscid, collect in such Quantities as to endanger the Vessels, or run over into the Receiver. This happens in the Distillation of Amber, and various other Matters. Hence the Necessity of adding Sand w: being in part unequally carried up by the Froth contributes by its Weight to break the Bubbles before they arise to a considerable Height in the Vessel.

y.th For regulating the Degree of Heat L. G.
In the Distillation of Essential Oils over
add water, wch can only acquire a deter=
minate Quantity of Heat, for preventing
Empireuma. ——

Before we proceed to the general Rules for
the practise of Distillation it may not be
improper to explain a few Terms.

When a Matter obtained by one Dis=
tillation is subjected to a second, that it
may be more entirely seperated from
Matter that adhered to it in the first,
such second Distillation is named Recti=
fication, Dephlegmation or Concentration.

Ardent Spirits after a second Distillati=
on leave a considerable Quantity of Water

wch they hold at first, and therefore be-
come more pure, hence they are said
wch some propriety to have undergone
a Rectification.

Dephlegmation takes its Rise from
Phlegm wch is the name Chemists have
given to water. This Term is properly
applied when we evaporate water
from any Body in wch it contained it.

When the parts of a Body separated &
diffused in any Medium are brot nea-
rer together, the Operation is called Con-
centration. But this Term how-
ever nor the foregoing are confined
altogether to the Operations of Distillation

In Cases 3d: and 4th: When a Matter Ob-
-tained by One Distillation is returned up-
-on y: same matter from wch: it was drawn
before, to be again distilled from it for Obtain
-ing a stronger Impregnation. such a
second Distillation is called a Cohobation. this
is of two kinds. the first is when the
Matter is returned on the Subject from wch:
it is drawn. the Second is when y: Matter
distilled, not upon the matter from whence
it was drawn, but upon a fresh portio-
-n of the same kind.

Distillation acording to y: Form of
the Vessels employed, is distinguished into
1: That per Ascensum in wch: y: Cucurbit

and Alembic are employed.

2ndly: That per Obliquum in ch. 2d: of Retort is employed.

3.Ly That per Descensum in ch: the Vapours are driven into a Vessel plaid below the Matter from which they are drawn, by means of Fire applied upon an Iron Plate, to the mouth of the containing Vessel. this Practise how-ever is now generally deserted.

In the Practise of Distillation we must have Regard to the Form and Matter of the Vessels we use.

As to the Matter Glass is certainly

Lent; as it is capable of containing the most subtile Bodies, of resisting y^e^ Force of any Menstruum. and has also y^e^ Advantage of Transparency. its ready Fusibility however is a Disadvantage.

White Flint Glass is the most fusable of all Others, yet it is to be preferred when y^e^ Degree of Heat will not act upon it. When a greater Heat is required than Flint Glass will bear we may use German Flint Glass; and if we require a greater Heat than this will bear, we may be greatly assisted by giving it a Coat of Windsor Loam. if we are obliged to employ a greater Heat than any of these (w^ch^ is seldom y^e^ Case) we must use Earthen Retorts.

As to the Form of the Vessels we shall understand them better by seeing the Figures than by verbal Description. The Vessels should be as Form as is consistent w: the Safety, and of the most uniform Thickness possible. When Bodies whose parts are nearly of an equal volatility are to be separated, it is common to employ an Alembic and Cucurbit of such a Height as y: the more volatile parts only may be able to ascend: but I find greater Advantage in this particular from a proper Regulation of the Heat from the Height of the Vessels. The Cucurbit and Alembic are also inconve-

as there are two Junctures to be closed. so
y^t the Retort and y^e Receiver w^ch have but
one Juncture, and y^t more easily closed, are
now very generally employed. the Only Ad-
vantage of the former is that from y^e wide-
ness of its mouth, we may get matter out
for which we sh^d be obliged to break a
Retort. —
with Regard to the filling of y^e bodies.
if the Bodies are fluid it must be done
by means of a crooked Glass funnel,
Care being taken not to let any of the
Matter drop upon the Neck of y^e Retort.
In putting in solid Bodies if any portion
sticks to the Neck, we must wipe it

carefully away. The Body according to the Common Rule may be $\frac{2}{3}$ full. This will do for ordinary Matters; but when y^{e} Subject is more disposed to Intumescence or affords a great Quantity of Elastiba=pours, the proportion must accordingly be diminished. — When y^{e} Subject is dry and not apt to swell, we may fill the Retort up to the Neck or near it. —

All the Matter shd be put in at once if it can be done, and no Addition made during the Operation. When this is requisite we ought to use tubulated ~~Bodies~~ Retorts, that y^{e} Addition may be made without destroying the Lutings. These Vessels necessary where the Fumes arising from

the matter to be distilled hinder the join-
ing of the Vessels. —

The Vessels sh? fit each other so exactly
as to prevent the Escape of the rising fumes.
their Junctures however may be more accu-
rately closed by the various kinds of Lutings
as Slips made of wet Bladder tied round,
or a Luting made of Meal and Water w: a
little Whiting, or One of Linseed Cake and
Water, or w: is still better. One made
of Clay, and a Quantity of Sand sufficient
to prevent the Clay from cracking w:
the Heat. it is proper to let up Lutings
be quite dry before we apply the Vessels to
the Fire. —

The proper Application of y? Fire

comes next to be considered. This should be done by very slow and gradual steps. Otherwise we must inevitably break our Vessel, or cause some part of the Matter to rise &c: will disappoint us of the Operation.

The Heat applied must be also regulated according to y^e^ Disposition of the Body to expand or intumesce. Here we may employ Sand or Brick Dust for the purpose abovementioned.

Many Bodies afford such copious Elastic vapours, that y^e^ utmost Caution in applying Heat will not prevent the bursting of our Vessels.

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In each Case several Expedients have been contrived 1st: the Opening the Lutes. 2nd the Tube to be inserted into the Receiver wch was invented by ye ingenious Mr Lewis 3d the Hole drilled at ye side of the Receiver. — The first Method is inconvenient and generally attended wth a Loss of our matter. to the 2nd we may Object that it is extremely difficult to determine the Size of our Tube; if too Large we loose much of the matter; if too small it will not conduct our Vapour fast enó to save our Lefel. — the third

Method invented by Mr. Godfroy is the most simple and convenient. the Hole must be stopped w.th a wood cupg in such a Manner as to be forced out before the vapours are sufficient to burst the vessels. —

many substances w.ch are distilled concrete before they get to the Receiver and by that means stop up the Neck of the Retort. we must avoid this by employing wide-mouthed Retorts & by keeping the Neck hot, that y.e fumes may continue fluid till they arrive at the Receiver. in distilling Butter

of Antimony we are obliged to apply burning Coals to the Neck of y^e^ Retort: but in most Cases hot water will be sufficient.

Distillation may be expeded by throwing Air into the Vessels. Dr. Hales proposed this as a convenient Method of distilling Sea water at a small Expence. Dr. Lethal from the Introduction of Air thro an Accidental Crack in his Vessel found that the Vitriolic Acid became volatile. We may convey Air into our distilling Vessel by using a tubulated Retort.

many Methods have been proposed

for separating when it is necessary $\frac{e}{y}$: several
matters arising successively in Distillation.
The best of these contrivances is $\frac{e}{y}$: Recei:
=ver w:th a Tube going from its Bottom
to w:ch different trials may be applied for
collecting the several parts as they arise.

If, as soon as the Operation is fini:
=shed the Vessels be opened, the cold Air
rushing in is sure to break them.
Besides many Vapours require some
time to condense w:ch by Opening the
Vessel too soon will be lost: or they
are frequently noxious. —

When several Matters are collected
in one Receiver they may be separated

according to their Specific Gravities, by a Cup constructed w: a proper Spout, or by a Seperatory Funnel. —

In the last place I must Observe 4: The Fumes escaping in the Course of the Operation are to be examined, for these being often very inflammable or deliterious may occasion considerable danger to a heedless Operator.

Sublimation

is conducted by the same principles as Distillation. its products are different as they are 1st in powder and are called Flowers, or 2: in solid Concretes and are then called Sublimates.

To this Anᵗ. of Chemical Operations it may be useful to add by way of Appendix an Anᵗ. of the different Methods of the Application of Fire. —

Appendix.

Of the Application of Fire. —

The Ancient Chemists Observing the Heat arising from Fermentation, from burning Bodies or culinary Heat, from the Rays of the Sun &c supposed that each of these was of a distinct & seperate nature; but it seems now to be the general Opinion of Philosophers, that there are only different modifications of the same active Principle of Fire,

The Heat Obtained by collecting the Suns Rays in a burning Glass, is often very necessary as it is most intense: but since the Heat Obtained from burning Bodies or culinary Fire is most conveniently and commonly employed in Chemical Operations we shall treat more fully of its Application. —

In the Application of the Heat communicated by burning Bodies we consider the

Direction of it, and 2d: Regulation of its Degree.

The Direction is of three kinds { 1st: the naked or Open Fire; 2d: the Reverbera: Furnace; 3rd: the transmitted Heat.

The 1st: is employed

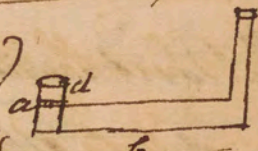
- When a great Degree of Heat is requi:
: red.
When the Matter to be acted Upon
cannot be committed to Vessels.
Where the Matter is not hurt by the
Contacts of burning Fuel. —
Where the Vessels employed are fit to
Sustain the imediate Action of burning
Fuel. —

The 2nd: or Reverberatory Furnace is
employed. —
When a great Degree of Heat is reqn:
When the Heat is to be applied to a
great Quantity of Matter or to a great
Number of Vessels at 1: same time. —

Where the immediate Contact of y^e^ Fire would disturb the Operation.

Where it is useful to inflame & consume the Smoak arising from burning Fuel.

This is effected well by the Focus Rhapnes represented in the Figure.



a is a Grate fixed at the Junction of the perpendicular short tube d, and the horizontal tube b

When a Fire is made on the Grate a the Air in the Tubes becoming rarefied is driven by the external Atmosphere violently thro the long tube c by w^ch^ a very entire Consumption of the Smoak & Combustibles.

This Furnace is employed lastly Where

the Direction of the Fire is best suited for collecting the Matters melted by it.

The 3d. or transmitted Heat is employd when the Heat is communicated to the containing Vessel thro' Sand, Water or Some other Body interposed. This is employed.

Where a moderate Degree of Heat is requi: Where a very gradual & exactly conducted Heat is necessary. for this purpose Sand is very convenient because both in receiving and loosing Heat it is extremely equable and gradual. -

Where an exactly determined Degree of Heat

is necessary. in this case we generally employ a Fluid which bears only a determined Degree of Heat. it would be a very useful Improvement upon y^e^ Digester to enable us to raise the Evaporating Heat of water above the common boiling point at 212, by regular and certain Degrees.

The Heat of Metal remains equal from the time it begins to melt till the whole is in Fusion. it has therefore been proposed to determine the Degree of Heat by throwing in a piece of unmelted Metal, successively as the first is fused. ——

Where the Matter to be operated upon may be hurt by a Communication w^th^ the

burning Fewel, or the Smoak arising therefrom. —

Where the Vessels employed are not fit for sustaining the immediate Action of the burning Fewel. —

Of the Regulation of the Degree of Heat

To be able to regulate the Degree of Heat it is necessary to know y^e^ Circumstances wch occasion a greater or lesser Degree of Heat. These are 1^st^ the Nature of y^e^ Fewel, i e the Quantity of Phlogiston in a given time. —

It not only depends upon y^e^ Quantity of Phlogiston, but also upon the Degree of Density of the Aggregate. thus Straw may have as large a proportion of Phlogiston

as wood, but being of a rarer & lighter
Texture, it burns away sooner, and ev:
yes ~~light~~ Heat. —
2ly The Quality of the Fuel being gi:
=ven the Increase of Heat depends upon
the Quantity inflamed. —
When the Rays of the Sun are collected
in a burning Glass, they again diverge
from the Focus, and the Intensene ss
of the Heat decreases in a Ratio with
the Distance from the Focus or Centre,
because there are fewer Rays in a given
Space. now we may consider every
inflamed point upon a Surface of a bur:
=ning Body as a Centre, or Focus from

which diverging Rays issue. it is cer-
=tain then that where a greater Quan-
=tity of matter is inflamed, there will
be a greater Number of inflamed points
and consequently a greater Heat.

3ly. The Quality and Quantity of the
Fewel being given, the Increase of
Heat is in proportion to y^e more or
less entire Inflamation of it. When a
peice of wood is put into y^e Fire
it is not totally inflamed, for a conside-
=ble part of it flies off in Smoke and
Soot. Now if we can by any means
inflame these, the Number of radiating
points will be encreased in a given
Quantity

of matter, and consequently the In-
tensness of the Heat. to this Cause
I attribute the great Increase of Heat
by blowing the Flame of a Candle with
a blow-pipe, for a strong Current of
Air investing the Flame confines the
parts, and by keeping them longer in
Contact w^th the Flame occasions a more
total Consumption.

4^ly The Degree of Heat is regulated by
the slower or quicker Inflamation of the
Fewel depending on the velocity of the
Air applied.

The Whole of the Consideration we
are now upon depends upon this. that
the Intensness of Heat is in proportion

to its Density. The Density encreases according to the quicker succession of the application of Heat, now since Inflamation cannot go on, unless the rarefied Air next the surface of the Body be succeeded by the fresh external Air, the quicker Inflamation will certainly encrease as the successions of fresh Air become quicker, & will depend upon the velocity of the Air applied.

This velocity of the Air applied is determined by Bellows, a Water Blast Colipile or the Structure of Furnaus.

In the Structure of Furnaus we

must attend principally to y^e Con-
-struction of the Chimney. from con-
-sidering the Principles upon which
Air is made to rush up a Chimney.
it will appear that the Velocity of it
is determined in some measure by
the Height of the Chimney, because
the Column of rarefied Air is encreased.
upon this Supposition, many People
the Iron-Founders in particular have
raised their Chimnies to a most erroneous
Height; but this is certainly unnecessary.
for M^r. Pott finds, that y^e Draught of
the Chimney depends more upon the
Ratio between the Diameter & y^e Height

than upon y^e^ Absolute Height of y^e^ Chim:
:ney. so that w^th^ a Diameter of a certain
proportion he Obtained the greatest
possible Heat from a Chimney only 8
Feet high. —

5:^th^ The more or less exact Confine:
:ment of the Heat arising from the
burning Fewel. —

any given Quantity of burning
Fewel exposed to the external air
upon all sides will have much less
Effect upon a Useful applied than if
it were enclosed by Brick work, or
otherwise as in a Furnace &c. it is
not only of Importance that y^e^ burning

Fuel be enclosed by some Body, but also that this Body be of such a Texture or Thickness as not readily to transmit Heat, and in general the Thicker the Wall the greater will be the Heat.

By the Consideration of y^{e} Regulation and Direction of Heat is ~~encluded~~ determined the Structure of Furnaces.

The Parts of a Furnace may be the Lesh-hole to receive the Ashes that they not block up the Furnace. the Focus or the place where the Fewel is burnt. the Laboratory or the place where the Matter to be Operated upon are plaid. the Chimney w^{ch} conveys a swift Curr^{t} of Air thro the Furnace.

The chief Species of Furnaces are

1st The Forge.
2nd The melting Furnace
3rd The distilling Furnace w. a naked Fire
4th The Assay Furnace
5th The Reverberatory distilling Furnace
6th The Iron Foundrys Furnace
7th The Potter's Furnace or Kiln.
8th The distilling Sand Furnace.
9th The Athanor
10th The Lamp-Furnace.

End of the Operations of Chemistry. —

Of the Chemical History of Bodies

The greatest part of Chemical Knowledge depends upon the Knowledge of Chemical Facts. Hence therefore we shall endeavour to deliver in a Systematic Manner; Our System however cannot be compleat since the Science itself is Otherwise. We shall consider the Objects of Chemistry in the Order which we observed in the first part of our Course, beginning w.th the saline Bodies as they have a more general Relation to Other Bodies than any Class whatsoever.

For the simple Salts & their Definition

see the former part of our work under y^e^
Objects of Chemistry. —

Each of the four Acids may be combined
w^th^ w: the ~~four Acids~~ three Alkalies into dif-
=ferent Neutrals, and as only one of
each can be combined at one it is
evident that only 12 Neutrals can be
formed by them. — The names and
various Combinations of w^ch^ I shall set
down in the following Table. the Acids
and Alkalies precede each other according
to their powers of Attraction. it is extreme
-ly useful to fix in our memories the
Combination of these Salts, & the Method by
which they may be decompos'd. the
Vitriolic Acid decompposes y^e^ Neutrals

composed by the other three. c/y nitrous
from formed by the muriatic & vegitable.
- the muriatic decompores that formed
by the vegitable.

Before we enter upon the history of
the different salts we shall say some-
-thing of their solution, & of the means em-
-ployed to recover them from their men-
-strua. water is universally a menstruum
of salts, and it is doubtful whether any
other bodies can dissolve salts but in
proportion to the ~~quantity~~ water they
contain. a cubic inch of water mixed
with a cubic inch of vitriolic acid will
be considerably less than two cubic

Inches, whereas Some Other Salts
mixed w^th water give the same or a
greater Bulk than they occupied
before. this may afford Subjects
of Speculation w^ch we shall not enter
upon at present.

Salts differ in their Degree of Solubility,
but w^t the exact proportion that may
be dissolved in a given quantity of water
we have not been able to determine, be-
=cause the Salts themselves are not
Steady in their Characters. let it Suf-
=fice that boiling water dissolves more
Salt than when it is at y^e common
Heat of the Atmosphere, and that

fixed vegitable Alkali is most soluble,
next regenerated Tartar, next Glaub. Salt
digestive Salt, vomion Salt, common
Ammoniac, common Nitre, Cubic Nitre,
Soft Alkali, and lastly Vitriolated Tartar.
no accurate Experiments have been made
upon the other Neutrals. the Quantity of
Salt soluble in water, is in proportion to
the Quantity of Air present in the water,
for if a saturated Solution of Salt & water
be put under the exausted Receiver of Eq:
Air Pump, a portion of the Salt will
immediately precipitate. hence we may
conclude that water when deprived of
some of its Air by Fire does not dissolve

as much as might be expected from the Degree of Heat encreased. Another curious Fact relative to the Solution of Salt is, that when water is saturated with common Salt, it will dissolve any other nearly in the same proportion that it would before the first Saturation. a saturated Solution of nitre added to common Salt dissolves nearly as much of it as if Nitre had not been previously dissolved, and even after the double Saturation the water will be capable of dissolving more Nitre. This may depend upon a fresh portion of water introduced by the common Salt. 12 or 14 Grains

of Corrosive Sublimate may be dissolved in Zi of water, but if we add a few Grains of Sal Ammoniac the water will dissolve four times as much. The Solution of Salts is also expedited by the Agitation of the Vessel, and the Division of the Solvend into smaller parts. —

Various are the Methods for recovering Salts from their Menstrua, by Evaporation, Crystalization, or Precipitation. — Alkohol added to a Solution of many Salts precipitates them E.g: if to a Solution of Epsom Salt be added a Portion of Alkohol, the former will be precipitated. Fixt Alkali has not in any State so much Water as it naturally

The Table of Neutral Salts

Acids	Alkalies		Neutrals
vitriolic Acid	Vegitable	makes	vitriolated Tartar
	Fossile		Glauber Salt
	volatile		vitriolic Ammon^{c}
Nitrous Acid	Vegitable	makes	Common Nitre
	Fossile		Cubic Nitre
	volatile		Nitrous Ammoniac
Muriatic Acid	Vegitab:	makes	Digestive Salt
	Fossile		Common Salt
	volatile		Common Ammon^{c}
Vegitab: Acid	Vegitable	makes	Regen^{d}: Tartar
	Fossil		Polychrest^{m}: of Rochelle
	volatile		Vegitab: Ammon^{c}

requires, therefore it precipitates metals
from their menstruums. — Acids have
also the same Effect upon those Salts
of which the Acid applied enters into the
Composition. as a proof of this we shall
find that fixed veg: Alkali added to a
Solution of Nitre precipitates it, and unites
wth the Nitre. and wth respect to 2d Second
Proposition we shall find yt y 2d addition
of concentrated vitriolic Acid to a Solution
of Glauber Salt in water is immediately
succeeded by a precipitation of y 2d Salt.
we may employ Evaporation for ob-
taining a Crystalization wth all y 2d Salts
except the volatile. the Practice is also
much less applicable to the Acids than to

the fixt and neutral salts. the Dirty however is proportionable to their power of Attraction, strongest in the vitriolic less in the Nitre. in removing salts from their Menstrua we may evaporate to Dryness, or Crystalization. the former practise is never to be employd except when the salt will not crystalize because salts when deprived of the water necessary for their Concretion suffers Decomposition, & often receive an Empyreuma. Even when Evaporation is requisite we ought to lessen y^e Applic-ation of Fire by every other Practise

that will assist us, by exposing it to y^e^
gentle Heat of the Sunor to the Action of
the Air. in those Operations we may use
Dr. Hales's Machine for promoting Eva-
=poration w^th^ great Advantage. hence we
see the Reason why Common Salt is
so much inferior to Bay Salt both
in the Beauty of its Crystals and Anti=
=septic Quality, the former being Ob=
=tained by y^e^ boiling heat, and the latter
by the gentle Heat of the Sun. The genral
Rule for knowing when y^e^ Evaporation
has proceed far enó, is to evaporate
'till a pellicle Appears upon y^e^ Surface

of the Liquor, and then set it to cool, and crystalize. This Rule however is not general. for in some Cases as in the Crystalization of Nitre no pellicle appears at all. Therefore we must judge by the Quantity of the Menstruum evaporated, or by taking a few Drops to cool, of this sort is Nitre. If we would have large fair Crystals we must cool the Liquor slowly, if it is cooled suddenly, and in large Vessels the Salt calcines. The Manufacturers of Gun-powder avail themselves of this Practice for reducing the Nitre to powder at the time they obtain it by Evaporation. When more Salts than One are dissolved

15/ in a menstruum we must seperate them by Evaporation, taking advantage of a great Disparity in the Shape or Size of their Crystals or of their Solubility in water. E.G. a Quantity of water that in y: com= =mon Temperature of the Air dissolves $\frac{1}{3}$ of Common Salt will dissolve $\frac{1}{5}$ of Nitre, but if the water be raised to a boiling heat, the Solubility of the Nitre is almost unli= =mited, while that of Common Salt is encreased in a proportion considerably less; hence it is evident if we evaporate the Liquor properly a large Quantity of Common Salt will be crystalized Whenale the Nitre is entirely suspended. do y: by repea= =ted Evaporation & y: Addition of fresh water

we may separate the salts very accurately.
This Practise occurs wherever Nitre is made,
& likewise where fossil Alkali obtained
from Sea weed, is to be separated from y^e
Common Salt which always adheres to
it. The Solubility of fossil Alkali is to
that of water :: 8 : 3. We must here ob-
serve that previous to the Evaporation
of mineral waters we ought to purify
them by Filtration, or Clarifications of
Animal Fluids, viz: entangling y^e particles
floating in a liquid, and retaining them
in a Coagulum.

That the Air is extremely requisite

for Crystalization appears from the following Experiment. If a supersaturated Solution of Nitre be closely confined while hot in a proper Vessel, the Liquor will remain for any time in the open Air perfectly fluid, but if the Vessel be opened, and y^e^ external Air admitted, the superfluous Quantity of Salt w^ch^ the hot Water suspended will instantly subside. —

It has been laid down as a certain Rule that we may distinguish Salts by the various Forms w^ch^ each assumes; yet this Rule has given Rise to innumerable Errors, since the Shape into w^ch^ any Salt concretes is never constantly uniform. for Instance common Salt usually

forms Crystals of a Cubic form, but two of them very frequently join, and form a Parallelopiped. some Salts form hexagonal Prisms, but these also form Cones or Pyramids of Cones. they often concrete in the same form: as Glauber Salt and Nitre which have been frequently mistaken for each other. all y^t we can say upon this Subject is that Vitriol.^d Tartar generally concretes into hexagonal Pyramids; Common nitre & Glauber Salt into hexagonal Prisms. y^e Crystals of the ~~Salts~~ former are usually largest. — Cubic Nitre into Rhomboidal, & common and digestive Salt into Cubical

Cryptals.

Salts not only concrete in particular forms, but also in a determinate position, generally vertical to the plain on w: ch they fix. common Salt concretes usually on the surface of the Liquor: Nitre in a perpendicular, and Glauber Salt in a horizontal Position to the Bottom of the Vessel. I formerly imagined that these Positions were very permanent, but I have found by Experiment that the Concretions begins where the Vessel is coolest, so that by applying Cold to one part of the Vessel, sooner than another we may determine at pleasure where the Salts shall begin to crystalize. I took this Hint from

Mr Reaumeur on Antimony. – This as we generally have it consists of a Bundle of Fibres whose Direction is from the Apex of the Cone towards the Basis. The Reason of this Direction of the Fibres seems to arise from the Shape of y^e^ Antimonial Horn, which is a Cone inverted, & consequently the Bottom would cool soonest; for Mr Reaumeur found that by keeping the Bottom of the Horn in warm Sand, and applying a cool Body to the Side, y^e^ Direction of the Fibres became horizontal.

Besides the Air which we have drawn is extremely necessary for promoting the

Crystalization of Salts, they all retain
a proportion of water, the Dissipation of
which is always attended with the Demolition of
their Crystaline Structures which may be again
recovered by a proper addition of water. 2dly
Crystals of Glauber salt retain $\frac{3}{4}$ of water,
Nitre receives only $\frac{1}{2}$ of water into its
Crystals. Vitriolated Tartar receives little
less. hence the Distinction of Crystaline &
Dilaquescent Salts. in Favour of 2dly Above
mentioned Salts which are disposed to crystalize
at the sides of the Vessels, if that be applied
thereto, the Crystals push each other till
they rise over the Brim. This was once
not a very surprizing Phanomenon,
& termed the Vegitation of Salts. There is a

curious Fact relating to Crystaline & deliquescent Salts, that the former generate Cold, and the latter Heat when mixed w: th water.

When Neutral Salts are crystalized w: th water, the Mass is expanded. Selenites (which have been very Absurdly kept from the Class of Saline, and transfered to y: e of Earthy Bodies) suffers a very remarkable Expansion when calcined, and mixed w: th water. Hence its usefulness in receiving the most minute Impression of a Mould, and hence y: e Bursting of a Vial if accurately, and suddenly closed. After being filled w: th a mixture of Selenites.

and water.

Having premised these general Observations concerning Salts we shall proceed to consider each particular Object of Chemistry in the following Order. 1st we shall examine whether the Substance is natural, or Artificial, simple or Compound? — If natural we shall examine in w.h State it is presented by Nature? if Artificial by w.h means it may be obtained? if Compound w.h Bodies compon it? — 2.dly we shall consider y.e Substance both in itself, and as relative to other Bodies, w.h may be strictly called its Chemical History, and this the whole I shall

adopt the Order before established begin-
-ning with the saline.-

Of the Vitriolic Acid

Vitriolic Acid is a native substance. nor does it appear that it can be produced by Art. it is seldom presented by Nature in a pure state, being generally combined w^th^ other Bodies, as w^th^ fossil Alkali into Glauber salt – w^th^ fossile Oils, but never w^th^ animal or vegitable Bodies.

It has been a matter of Controversy whether it appears even in fossile Oils. it unites w^th^ Phlogiston into Sulphur, & as Sulphur enters into the Composition of most Metals, the Vitriolic Acid frequently unites w^th^ them especially w^th^ Iron forming green – w^th^ Copper forming blue, and w^th^ Zine forming White vitriol. it is found

w: Earths. forming w: the Calcarious Selenites, w: Magnesia a Salt much resembling Glaubers — and w: part of com: = mon Clay Alum. it is found in Mineral waters as accompanying other Bodies diffused therein, or if it be found pure it is only in Consequence of the waters wash: = ing it from some Body w: has suffered a Decomposition. this often happens to Pyr: = ites from the action of the Air. we sometimes see the Effects of Vitriolic Acid in y Air, but whether it is there present in its seperate State, or attending other Bodies exhaled into that fluid we have not determined by any Experiments. the fol: = lowing

Arguments are offered to prove that this Acid exists in the Air independant of other Bodies 1.st If you expose fixt vegitable Alkali to the Air, and then crystalize it, the Crystals will have the Appearance of Vitriolated Tartar. 2.nd That Metals are corroded, and the Colour of Silks changed by being exposed to the Air. To the 1.st of these Argum.ts we may Object that no satisfactory proof to shew that the Salt produced is was Vitriolated Tartar. to the 2.nd we may Object that the very same Effects arise not only from the Action of Acids, but of y.e Alkalies and neutral Salts, many of which we might more reasonably expect to find in the Air than the Vitriolic. This Acid

is so universally diffused throughout y^e^
Bowels of the Earth, y^t^ some have supposed that it floated w^th^ vapours in all
subterraneous Caverns, which Hypothesis
is true perhaps w^th^ Respect to all especially
such as are deliterious. When in y^e^ floating
State just mentioned to which it is reduced
by an Accidental Decomposition, it becomes
volatile. it appears likewise y^t^ it is
present in the Electrical Ether, from the
Effects which y^e^ latter has in changing y^e^
Colour of Roses and violets — from y^e^ Smell
which it produces after Explosion, and
from the Taste w^ch^ People have sometimes

perceived after an Electrical shock. if we were more certain of the presence of Oxygen in the Electrical fluid, we might be induced to recall the objections made to the Universal Diffusion of it thro the Atmosphere. the Phosphorus of some Animal Substances contains an Acid very similar to it, but not proved actually to be the Vitriolic. After the Incineration of Vegitables a Salt is found very much resembling Vitriolated Tartar. the Experiments however upon this subject are few, deficient and inaccurate. it must still be a subject of future Inquiry whether the Salt of the Vegitables is really Vitriolated Tartar?

If so, whether it originally existed in the entire vegitable? – or whether it was introduced in consequence of Incineration?

The Vitriolic Acid is chiefly procured by art for the purposes of art, from Vitriol, Sulphur and Alum. The practise upon y^e^ latter is now entirely neglected. Vitriol & Sulphur are most generally employed; of these Sulphur is to be preferred since it is supposed to contain $\frac{15}{16}$ of Vitriolic Acid. You will find Directions for conducting these Processes in Macquer and Boerhaave. I must here observe y^t^ I shall seldom enter into a Detail of the Procpss, as they are described w^h^ sufficient accuracy by Macquer

I shall always therefore suppose that you have Recourse to this Book, & only make a few Observations as I find occasion.

With Respect to the Practise upon Vitri=
=ol I shall Observe that y^e^ Calcination before Distillation, serves not only to dissi=
=pate the large proportion of Water con=
=tained in the Vitriol w:^ch^ might otherwise Obstruct the Process, but also to prevent the Fusion of the Vitriol during Distilla=
=tion, w:^ch^ would infallibly break our Vessels. Earthen Vessels are most proper for this purpose. The Heat must be very gra=
=dually encreased till watery Vapours arise,

then we must keep it equal' till they rise
less copiously. the Heat must then be
encreased till the Acid begins to rise,
the Heat must again be preserved equal
till white Clouds appear; after these
are removed we may encrease the
Heat to any possible Degree. the Stop-
-ping the Distillation at a proper time
can only be understood by those who
have been very conversant in the Ap-
-pearances which occur in the process.

Tho Sulphur contains such a re-
-markable proportion of Acid, yet not
more than 2 or 3 Ounces could be Ob-
-tained from a pound of Sulphur by any

of the former practises. the rude unprofita-
-ble practise invented by Geber has long
been deserted. the next method was "per
Campanam" but the Air in the Bell soon
became too hot for condensing y^e Fumes,
w^ch arose from the Sulphur below. Homberg
improved upon this Method by inserting a
long tube for admitting the Air. this tube
suffered a great Quantity of the Fumes
to escape. in short all Attempts were
ineffectual till a Chymist of Holland some
say one Cornelius Drebel practised it
w^th excessive large vessels, & w^th the Addition
of Nitre, w^ch enabled the Sulphur to inflame
without any imediate Communication w^th

the Air. the Quantity of Nitre is said to have been about 6 pounds to 100 of Sulp.r: These proportions are so unequal, that their union w.ch would certainly take place in Distillation was attended w.th no Incon-venience. Mr Ward introduced a Method into England, and Obtained a Patent for the practice, by w.ch he procured a very great Proportion of Acid from the Sulphurs. a Gentleman having discovered y.e Proc.s erected a Factory at Preston-Pans in Scotland. it is however at present in the hands of very few People. various con-jectures have been formed concerning the Method of this Practice. from the

uncommon Size of the Vessels wch they
presume, some have imagined that it is
only some trifling Improvement upon
the Method just mentioned of Cornelius
Drebbel. Mr. Dofsy in his "Laboratory laid
open," pretends to have discovered ye true
Practice, but whether wth certainty or not
we cannot determine.

The Practice wch we have directed for green
vitriol must be observed in ye Distillation
of other vitriols or Alum.

This Acid as we receive it from ye Manu=
=factures always contains a large pro=
=portion of water, and it is more or less of a
dark Colour occasioned by ye presence of
foreign and chiefly inflamable Matter, all

of which change the Colour of this Acid. to Obtain it then free from adhering matter we must subject it to frequent Distillations. - the transparency of the Acid is a mark of sufficient purity for common purpo- -ses. but the most certain Rule is the Examination of its Specific Gravity at every Distillation, and when its Gravity is to ȳ of water as 18 to 10 it is sufficiently con- -centrated for any purposes of Arts or Chemistry. we also rectify the Acid of Vitriol by open Evaporation, as the water and Phlogiston are more volatile than the Acid; but this is attended w: 2d a large Dissipation of ȳ Acid.

Having now considered the different methods of Obtaining the vitriolic Acid,

let us next examin its Properties alone & as relative to other Classes of Bodies. the Vitriolic Acid is generally fluid, tho it sometimes forms icy Concretions. Mr Hellot says it is reduced to a solid form by distilling it w: intense Heat & close Vessels. I suspect that its Disposition to Solidity depends upon the presence of inflammable Matter. this Subject however is not sufficiently illustrated by Experiments, so y: we are not certain by w: it is rendered solid, nor can this Effect be produced by Art tho it often happens accidentally. its Specific Gravity is greater than y: of any other Fluid except Quicksilver. When

pure it is perfectly colourless & emits
no sensible Odour. When mixed w: a very
small portion of Phlogiston it assumes a
brown Colour, and if the Quantity is
encreased it will proceed to perfect Black-
-ness.

It unites w: every Species of fluid effer-
-vescing and generating Heat. I dare
not however affirm whether it unites
w: the pure Acid, or the Water they gene=
=rally contain. They certainly unite of=
=ten into a Substance possessing y: Proper=
=ties of neither. Thus Nitre & Muriatic
Acid do not act upon Gold in a seperate
State, but when combined they form an

Aqua Regia that readily dissolves that Metal. —

It unites w. all Alkalies effervescing and generating Heat. The former of these appearances is not universal since there is a State of the Alkali in w. the addition of bitriolic Acid is attended w. no Effervescence but more of this when we treat of Alkalies. — Two Phanomena however constantly result from their union viz: a Generation of Heat, and the Production of a Neutral Salt, possessing the Properties of neither the Acid nor the Alkali. These Salts differ according to the Species of Acid employed. they may be seen in the Table of Neutral Salts. it also dissolves & attracts

Alkalis more strongly than any other Acid,
and it is in consequence of this property
y^t we can separate y^e Acids from any other
Neutral Salts as we observed before. —

The Vitriolic Acid unites wth Oils in gener-
=al, producing Effervescence, Heat, and
more or less of a dark Colour. This Mixture
subjected to Distillation produces a portion
of genuine Sulphur. it is doubted whether
Vitriolic Acid admits of any Combination.
One would imagin that it does not,
since Sulphur appears always separa-
=ted, yet some of its Effects deserve Attention.
Sulphur moistned wth Oil runs in y^e Air
& Deliquium, and becomes Inflam^{ble}.

- It suffers a change also by Digestion.
Muriatic Acid unites w: all Metallic Bo=
=dies except Gold. Some have tho't that
Gold might be combined w: it. it suspends
many of them in a fluid Form, others it
only corrodes. it will not dissolve Iron
when highly concentrated, but requires Di=
=lution. This is the case also w: Zinc, but
Copper requires a very concentrated Acid
for its Solution. Most of the other Metals
require not only a very concentrated
Acid for their Solution, but also y Assis=
=tance of boiling. Such are Silver Lead
Tin Antimony. Bismuth, Quicksilver
& Arsenic. its Effects upon Platina & Nickel

Cobalt have not been ascertained as
these Metals have been but lately disco=
=vered.

Vitriolic Acid unites 7th w: Absorbent Earths
of all kinds 7th w: Effervescence & Heat. 7th w:
Species called Calcarious, it forms Selenites,
7th w: magnesia Alba a purging bitter Salt,
7th w: Animal Earth a Salt to 7th w: no name
has been assign'd, and 7th w: Earth of Alum
a Salt of the same name. W: Margraff
informs us that Earth of Alum, and
Vitriolic Acid will not crystalize except
a over proportion of the Earth be added.
This is a curious Fact, the Rationalia
of which we do not understand. —

Vitriolic Acid unites w. water. in a fluid State it generates Heat, but w. Ice it ge-
-nerates Cold. in a concentrated State
it attracts moisture from the Air.

We have not yet determined its Effects
upon the Air. it seems however to show
a peculiar Relation to the Phlogistic Species.

It dissolves ~~Spirit~~ all, or a part of
every Animal, & Vegitable Substance,
generating Heat, and producing more
or less of a black Colour, in proportion to
the Phlogiston they contain. it shews also
the Vinous Acetous, and Putrefactive Fer-
-mentations.

Of the Volatile Vitriolic Acid.

We have considered the Vitriolic Acid

heretofore in its first state, ponderous in-
-odorous, and emitting no Fumes. let
us now consider it in its volatile state,
less ponderous, odorous, and copiously
emitting ~~volatile~~ pungent Fumes. Dr. Stahl
accidently discovered the method of volati-
-lizing this Acid. While he was distilling it
a sudden Stream of Air broke ℈ Vessel, &
on Examination he found that ℈ Liquor
was volatilized. it is obtained also volatile
from Sulphur, White vitriol, & from all
Combinations of the Acid w: Bils or Alko-
-hol. The volatile Acid is disposed like ℈
former to congeal in w: & at it loses
its Odour, but recovers it w: Fluidity.

It discharges the Colour of violets altogether, without turning them red. their Colour may be recovered by a fixt alkali. Neutrals formed by it may be decompos'd by the fixt vitriolic nitrous, or muriatic Acids. it unites with all the other Classes of Bodies nearly in y^{e} same manner as when fixt. its chief Peculiarities are as follows. it is more powerful Menstruum to alkalies than y^{e} fixt are. the fumes of 16 ounces of Sulphur will dissolve a greater Quantity of Acid, than 16 ounces of the most concentrated fixt Acid. its Effects upon Inflamables are inconsiderable. it unites difficultly with Alkohol, nor will their union produce

Ether. its Effects upon Metallic, Earthy watery, and Aerial Bodies are nearly y^e^ same as those of the first, Only less powerful. the same Observation is true w^th^ Respect to y^e^ Animal and Vegitable. it may be render-ed first by a gentle Calcination w^th^ fixt Alkali; — by addition of water or by com-munication with the Air for a long time. — For an Acc^t^ of the Synonima of this kind of all the Other Salts, see Black's Chimistry.

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